Shipshewana Lake Aquatic Vegetation Management Plan

Lagrange County, Indiana

2006 - 2010

http://129.79.145.7/arcims/statewide%5Fmxd/viewer.htm

Prepared for:

The Shipshewana Community Lake Improvement Association

3560 N 920 W
Shipshewana, IN 46565

Prepared by:

Aquatic Weed Control

P. O. Box 325
Syracuse, IN 46567

Executive Summary

The following report outlines a long-term plant management strategy for Shipshewana Lake. Aquatic Weed Control was contracted by the Shipshewana Community Lake Improvement Association to conduct aquatic vegetation surveys and propose a management plan based on the results of these surveys. Funding for this plan was provided by the Shipshewana Community Lake Improvement Association and the Indiana Department of Natural Resources (IDNR) through the Lake and River Enhancement (LARE) program.

In 2006, Aquatic Weed Control conducted two aquatic vegetation surveys to characterize the plant community of Shipshewana Lake. An early season survey was conducted on May 17, 2006, and a late season survey was conducted on August 2, 2006. Each survey followed protocol established by the IDNR, and consisted of a Tier I reconnaissance survey and a Tier II qualitative survey. The Tier I survey is designed to give an overview of the plant structure in the lake, while the Tier II survey describes individual species distributions and abundances in more detail.

Historically, plant management on Shipshewana Lake was limited to spot treatments conducted at the request of individual property owners. Extensive dredging has also taken place at Shipshewana Lake (1999) with funding from the Indiana division of Soil Conservation (Koza, 2002). However, excessive exotic and native vegetation continue to be a problem. Based on the results of the 2006 surveys, a management plan was constructed to help reach the three major management goals established by the IDNR for all Indiana public lakes, including those applying for LARE funding. These three goals are listed below.

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality and is resistant to minor habitat disturbances and invasive species.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant and wildlife resources.

The 2006 vegetation surveys of Shipshewana Lake found a plant community with very low species diversity (0.56). Only 4 species were collected in the August 2006 Tier II survey. Three of these 4 plant species were native to Indiana waters, while Eurasian watermilfoil (*Myriophyllum spicatum*) is an invasive species. This plant species provides poor fish habitat, crowds out beneficial native plant species, and can impair recreation when present in great abundance. Eurasian watermilfoil is of special concern in Shipshewana Lake as it was found throughout the entire lake in moderate to high abundance in both 2006 surveys.

Water quality and plant community structure pose some unique challenges to reducing the Eurasian watermilfoil population in Shipshewana Lake. Shipshewana Lake is extremely fertile, making it prone to severe planktonic algae blooms. These blooms give the water a lime green “pea soup” appearance. The lake also has an overabundance of coontail *(Ceratophyllum demersum*). Although coontail is a native plant species, its overabundance impairs recreation significantly during the summer months at Shipshewana Lake.

When an entire lake is infested with Eurasian watermilfoil, a whole lake treatment using the herbicide Sonar (active ingredient: fluridone) is usually the most effective and cost efficient way to provide control. Environmental risks are usually very, low, posing little or no danger to native plants or fish. In Shipshewana Lake, environmental risks are higher than normal, not because of the herbicide, but because of the side effects of removing the Eurasian watermilfoil from such a fertile lake. With the removal of Eurasian watermilfoil, native plants usually do very well. Because of the low plant diversity in Shipshewana Lake, coontail would likely replace Eurasian watermilfoil in previously infested areas. Normally this is desirable, but coontail is so abundant in Shipshewana Lake that it may cause even more recreational problems. Since coontail is a native species, LARE funding cannot be awarded for its treatment.For these reasons, it is recommended that the entire Lake be treated with fluridone at a concentration of 8 parts per billion (ppb) in 2007. This should provide control of Eurasian watermilfoil and should also provide some control on coontail as well. LARE will only fund a treatment of 6 ppb, which is the lowest concentration of fluridone that will control Eurasian watermilfoil. An additional 2 ppb of fluridone should be added to the treatment to bring the concentration up to 8 ppb, and control coontail. This additional 2 ppb of fluridone must be privately funded. Follow up spot treatments using 2, 4-D will likely take place in years following the fluridone treatment.

It is important that the public be aware of the risks of this management plan on Shipshewana Lake. Reducing the Eurasian watermilfoil and coontail populations will free up nutrients in the lake, which will likely result in very heavy planktonic algae blooms. This will make the water extremely green and may prevent other native plants from growing. Extremely heavy algal blooms could possibly cause a fish kill, although it is not expected. Because of poor plant diversity in Shipshewana Lake, it is not expected that beneficial native plants will quickly fill the void left by Eurasian watermilfoil as they might in some lakes. Also, it is not known how long coontail will remain at acceptable levels after 2007. Coontail re-growth could significantly impair recreation. Even with these risks, this course of action should provide the best opportunity to improve what is now a very difficult plant situation on Shipshewana Lake. Treatment cost estimates for this project are included below. Survey and planning costs are estimated at $4,000 per year, but may be reduced pending LARE survey and planning requirements.

Project	2007	2008	2009	3 Year Cost Totals
Whole Lake Fluridone Treatment - 6ppb				
Total Estimated Costs	$ 26,300	$0	$0	**$ 33,250**
LARE share – subject to availability	$ 23,670			**$ 27,045**
Association's Share	$ 2,630			**$ 6,205**
Additional 2 ppb to Control Coontail Additional Cost to Association (Not Eligible for LARE Funding)	$3,200			
Follow Up Spot Treatments using 2, 4-D				
Total Estimated Costs	$0	$ 1,875	$ 1,875	
LARE Share – subject to availability		$1687.50	$1687.50	
Association's Share		$187.50	$187.50	

Acknowledgements

Aquatic vegetation surveys conducted on Shipshewana Lake were made possible by funding from the Shipshewana Community Lake Improvement Association and the Indiana Department of Natural Resources through the Lake and River Enhancement program (LARE). Aquatic Weed Control would like to extend special thanks to Indiana Department of Natural Resources (IDNR) District 3 biologist Jed Pearson for providing procedural training for both Tier I and Tier II aquatic vegetation surveys. Gwen White and Angela Sturdevant, aquatic biologists for the LARE program provided valuable consultation regarding the requirements and objectives of this lake management plan. District 2 Fisheries Biologists Neil Ledet and Larry Koza also provided valuable input and consultation regarding management strategies at Shipshewana Lake. Brad Fink and Jason Doll provided assistance and training for data analysis computer programs. Aquatic Weed Control would also like to thank the members of the Shipshewana Community Lake Improvement Association for their commitment to improving this lake and for valuable discussion and input brought forward at the informational meeting held on November 11, 2006.

Table of Contents

Executive Summary II

Acknowledgements IV

Table of Contents V

List of Figures VII

List of Tables VIII

1.0 Introduction 8

2.0 Watershed and Lake Characteristics 8

4.0 Fisheries 12

6.0 Vegetation Management goals and Objectives 13

7.0 Past Management Efforts 14

8.0 Aquatic Plant Community Characterization 15

8.1 Methods 15
8.1.1 Tier I 16
8.1.2 Tier II 17
8.1.3 Analytical Methods 20
8.2 Results 20
8.2.1 Tier I Results 20
8.2.2 Tier II Results 27
8.3 Macrophyte Inventory Discussion 32
9.0 Aquatic Plant Management Alternatives 32

9.1 No Action 33
9.2 Institutional-Protection of Beneficial Vegetation 33
9.3 Environmental Manipulation 34
9.3.1 Water Level Manipulation 34
9.3.2 Nutrient Reduction 34
9.4 Mechanical Controls 35
9.4.1 Mechanical Cutting and Harvesting 35
9.5 Manual Controls 35
9.5.1 Hand Pulling, Cutting, Raking 35
9.5.2 Bottom Barriers 36
9.6 Biological Controls 36
9.6.1 Water Milfoil Weevil 36
9.6.2 Grass Carp 37
9.7 Chemical Controls 37
9.7.1 Aquatic Herbicides 37

10.0 Public Involvement 38

11.0 Public Education 40

12.0 Integrated Treatment Action Strategy 43

13.0 Project Budget 45

14.0 Monitoring and Plan Update Procedures 45

15.0 References 46

16.0 Appendices 48

16.1 Calculations 48
16.2 Common Aquatic Plants of Indiana 49
16.3 Pesticide Use Restrictions Summary: 56
16.5 Resources for Aquatic Management 58
16.6 State Regulations for Aquatic Plant Management 59
16.7 Species Distribution Maps 61
16.8 Data Sheets 65
16.9 Permit Application 77

List of Figures

Figure 1: Shipshewana Lake Land Use 9
Figure 2: Shipshewana Lake Bathymetric Map 10
Figure 3: Shipshewana Lake Problem Plant Area 11
Figure 4: Shipshewana Lake Submersed Plant Beds 23
Figure 5: Shipshewana Lake Emergent Plant Beds 26
Figure 6: Shipshewana Lake Tier II Sample Site Locations 27
Figure 7: 2006 Coontail Sites 61
Figure 8: 2006 Eurasian Watermilfoil Sites 62
Figure 9: 2006 Leafy Pondweed Sites 63
Figure 10: 2006 Sago Pondweed Sites 64

List of Tables

Table 1: Scientific Names of Submersed Aquatic Plants 8
Table 2: 2002 IDNR Fisheries Survey Data 12
Table 3: Sample Depth by Trophic State 18
Table 4: Sample Sites by Lake Size and Trophic State 18
Table 5: 2006 Tier I Submersed Plant bed Summary 21
Table 6: 2006 Tier I Emergent Plant Bed Summary 24
Table 7: Fall 2006 Data Analysis: All Sites 28
Table 8: Fall 2006 Data Analysis: 0 - 5 Foot Depth Contour 28
Table 9: Fall 2006 Data Analysis: 5 -10 Foot Depth Contour 28
Table 10: 2006 Tier II Site Frequencies 29
Table 11: 2006 Tier II Mean and Relative Densities 30
Table 12: 2006 Tier II Dominance Values 31
Table 13: 2006 Tier II Relative Frequencies of Occurrence 32
Table 14: Shipshewana Lake Public Questionnaire 39
Table 15: Treatment Options and Costs 43
Table 16: Shipshewana Lake Cost Estimates 45
Table 17: Pesticide Use Restrictions 56
Table 18: Public Questionaire Sample 57

1.0 Introduction

Aquatic Weed Control was contracted by the Shipshewana Community Lake Improvement Association to develop a long-term aquatic vegetation management plan. Funding for this report was provided by the Shipshewana Community Lake Improvement Association and the Department of Natural Resources through the Lake and River Enhancement (LARE) program.

When a person registers a boat within the state of Indiana a lake enhancement fee is included in the cost of registry. Two thirds of this money is then used to fund projects designed to improve the quality of Indiana lakes. These funds are divided between diagnostic studies, construction projects, aquatic plant management and sediment removal.

The surveys included in this report, as well as the management plan, are required by the state to receive funding to treat the lake for exotic aquatic vegetation. Should a lake be selected for LARE funding, up to 100,000 dollars can be awarded for a whole lake treatment. Following a whole lake treatment up to 20,000 dollars per year can be awarded for up to 3 years for the maintenance of aquatic invasive plant species. If the whole lake is not treated, up to 20,000 dollars can be available annually for up to three years. Requests for funding are reviewed by the LARE office and funds will be distributed at the discretion of the director of the DNR.

This project was initiated to take a more aggressive approach to controlling Eurasian watermilfoil in Shipshewana Lake. Eurasian watermilfoil is present throughout Shipshewana Lake in moderate to high abundance. It is most abundant in late spring and early summer. In mid to late summer Eurasian watermilfoil abundance declines as water temperatures and algal blooms increase. The proposed treatment strategy in this report is aimed at providing effective control for Eurasian watermilfoil while minimizing environmental risks, improving fish habitat and enhancing recreational opportunities at Shipshewana Lake.

Table 1 is provided for reference regarding plant names commonly used in this document.

Table 1: Scientific Names of Submersed Aquatic Plants

Scientific Name	Common Name
Myriophyllum spicatum	Eurasian Watermilfoil
Ceratophyllym demersum	Coontail
Potamogeton pectinatus	Sago Pondweed
Potamogeton foliosus	Leafy Pondweed

2.0 Watershed and Lake Characteristics

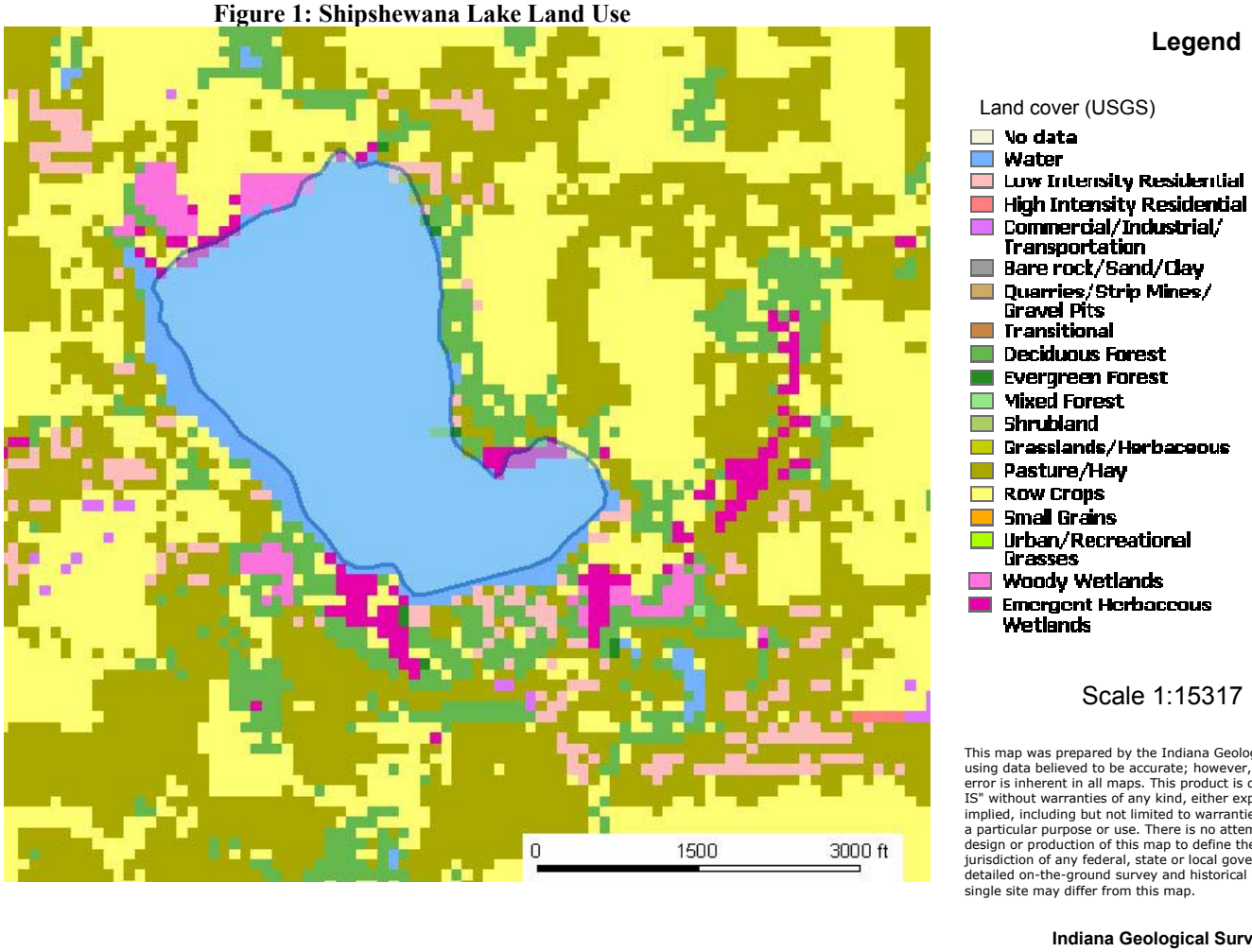
Shipshewana Lake is located in western Lagrange County, near the town of Shipshewana, Indiana. It has 202 surface acres with a maximum depth of 14 feet and an average depth of 7 feet (Tyllia, 2000). Cotton Lake Ditch is the lake's major inlet entering from the south (Koza, 2002). The lakes outlet is Page Ditch which exits the lake along the east shore and flows into Taylor Lake and The Pigeon River.

Shipshewana Lake has had a history of poor water quality and high levels of nutrient loading. In 1983, a request was submitted to the Indiana Department of Environmental Management to evaluate the Shipshewana Lake watershed (Koza, 2002). International Science and

Technology conducted a feasibility study to improve water quality at Shipshewana Lake. This study recommended that dredging should take place to remove excess sediment from the lake. The dredging project was conducted in 1999, and removed approximately 227, 500 cubic yards of sediment from Shipshewana Lake. However, the project was never completely finished, due to a lack of funding. Total costs for the project was around $2.4 million (Koza, 2002).

Figure 1 is a computer generated map showing land uses in the immediate area around Shipshewana Lake. It comes from Indiana's interactive map produced by the Indiana Geological Survey. This map is available at the following address:
http://129.79.145.7/arcims/statewide%5Fmxd/viewer.htm

Figure 1: Shipshewana Lake Land Use



The majority of the land in the watershed is used for agricultural purposes. Also, approximately 50 percent of the shoreline of Shipshewana Lake is developed, making residential and agricultural uses primary sources of nutrient loading for Shipshewana Lake.

Water quality is low when compared to many Indiana lakes. Secchi disk readings range from 1.5 (Koza, 2002) to 4 or 5 feet in early spring. Water clarity decreases in summer due to algal

blooms. The bottom sediment is high in organic matter, and is very conducive to plant growth.

Figure 2 is a bathymetric map of Shipshewana Lake. The entire lake is very shallow, with the entire southern section of the lake being 6 feet deep or less. The deepest spot in the lake is a small 14 foot hole in the north central part of the lake.

The north shoreline of the lake is the largest undeveloped portion of the lake. It is covered by a large wetland which should be protected to prevent a further decrease in water quality.

Figure 2: Shipshewana Lake Bathymetric Map

3.0 Lake Uses

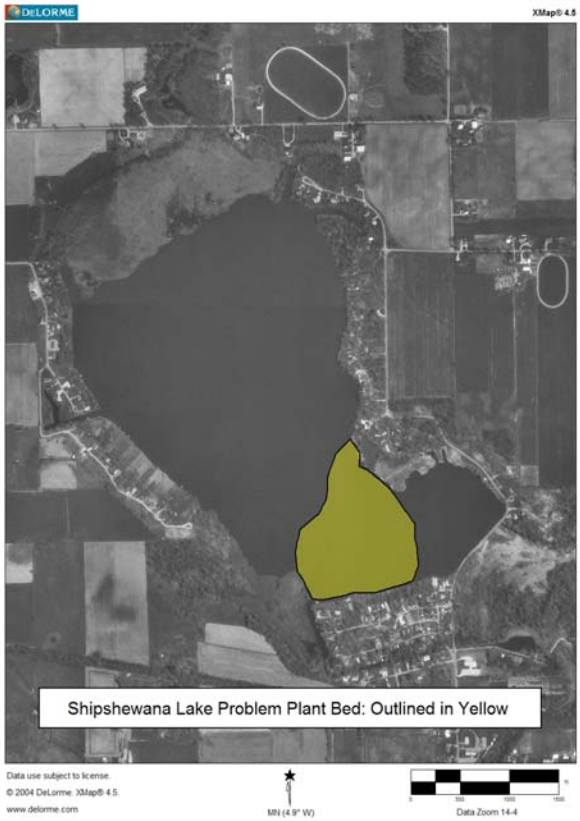
Shipshewana Lake is valuable to both lake residents and other lake users as well. There is an IDNR public access site for Shipshewana Lake, located on the south shoreline of the lake just off of country road 905 W. A county park is also located along the eastern shoreline of the lake. Any management practices implemented on this lake will benefit both the lake residents and a large number of stakeholders who visit the lake on a regular basis.

Shipshewana Lake is a very popular lake for largemouth bass fishermen. It is known as one of the best bass fishing lakes in the northern part of the state. Fishing for black crappies can also be very good, although crappie populations tend to cycle. Fishing can be especially good in early spring before excessive plant growth and algae blooms become a problem.

Shipshewana Lake is also an extremely popular ice fishing lake. District biologists have observed over 100 ice anglers on the lake at one time. It is especially popular at early ice when larger, deeper lakes may not yet be frozen.

Eurasian watermilfoil and coontail place severe limitations on recreational use during the summer months. Many boats have trouble traveling from the public access site to the north end of the lake because of the excessive plant growth in the south end of the lake. Extremely dense plant beds in the south end of the lake make boating very difficult for those wishing to enjoy the lake. The very dense plant bed causing the most severe recreational limitations is outlined in the map below. This area was treated in 2006 to provide some relief, although by the end of the summer vegetation was still very dense in this area.

Figure 3: Shipshewana Lake Problem Plant Area



4.0 Fisheries

Six fisheries surveys have been conducted on Shipshewana Lake. These surveys have taken place in 1968, 1975, 1983, 1986, 1989, and 2002. The most recent fisheries survey (June 3-7, 2002) used electro-fishing, gill nets, and trap nets to collect 1424 fish with a total weight of 917 pounds (Koza 2002).

Fifteen species of fish were collected, with black crappies being the most abundant fish by number (34%), and carp having the largest total weight (36.2%). Bluegills were the second most abundant fish by number (28.3%), and golden shiners were third at 8.4%. Yellow perch were fourth in abundance at 7.4 % and largemouth bass were fifth at 7.3%.
Of the 104 largemouth bass collected, 9.6 percent were of harvestable length. Growth rates for all bass except for age IV + fish were above average for northern Indiana Lakes.

Northern Pike were stocked in Shipshewana Lake in 1985 and 1987. Initially, the pike population was stable, and 24 fish were collected in the 1989 survey, ranging from 17.7 to 33.0 inches. However, no northern pike were collected in the most recent fisheries survey Koza (2002).Table 2 summarizes the most recent fisheries survey conducted by the IDNR.

Table 2: 2002 IDNR Fisheries Survey Data

SPECIES AND RELATIVE ABUNDANCE OF FISHES COLLECTED BY NUMBER AND WEIGHT

*COMMON NAME OF FISH	NUMBER	PERCENT	LENGTH RANGE (inches)	WEIGHT (pounds)	PERCENT
Black crappie	487	34.2	2.7-10.2	111.49	12.2
Bluegill	403	28.3	2.1-9.2	79.06	8.6
Golden shiner	119	8.4	5.4-8.3	12.91	1.4
Yellow perch	106	7.4	6.9-11.8	33.13	3.6
Largemouth bass	104	7.3	4.5-19.1	74.89	8.2
White sucker	71	5.0	10.1-19.8	112.00	12.2
Common carp	44	3.1	10.2-33.3	332.15	36.2
Spotted gar	30	2.1	11.3-35.6	96.08	10.5
Yellow bullhead	22	1.5	6.5-12.3	12.51	1.4
Brown bullhead	16	1.1	7.1-13.3	12.49	1.4
Pumpkinseed	9	0.6	3.8-6.3	0.83	0.1
Bowfin	7	0.5	18.4-27.3	36.24	4.0
Warmouth	4	0.3	4.4-4.9	0.28	0.0
Channel catfish	1	0.1	20.3	3.16	0.3
Chestnut lamprey	1	0.1	7.3	0.00	0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
		0.0			0.0
Total (15 Species)	1424	100.0		917.22	100.0

*Common names of fishes recognized by the American Fisheries Society.

5.0 Problem Statement

Excessive plant growth from Eurasian watermilfoil and coontail in Shipshewana Lake is causing very severe recreational problems and is competing with more beneficial native plants.

Eurasian milfoil is found throughout Shipshewana Lake in moderate to high abundance. Eurasian milfoil is of primary concern because of its aggressive nature and its destructive effects on lake ecosystems. This nuisance species grows and spreads rapidly, forming dense weed beds that rob native plants of the light and nutrients they need to survive.

In lakes where Eurasian milfoil is left unchecked, well-diversified plant communities can be decimated, although in some lakes, native plants compete well with Eurasian watermilfoil. Eurasian milfoil has the ability to "overwinter," giving it a distinct growth advantage over many native plants. The milfoil lies dormant during the winter months instead of dying completely. As spring arrives, the dormant milfoil plants have a head start on many native plants and reach the surface faster, shading out the natives. Eurasian watermilfoil grows profusely, provides poor fish habitat, inhibits boat navigation, and causes annoyances and even serious recreational hazards to skiers, swimmers, and other members of the public wishing to enjoy the lake.

Reducing the Eurasian watermilfoil population without addressing the excessive coontail growth at Shipshewana Lake will likely result in an explosion of the coontail population, which will further impair recreation. To provide any recreational advantage, the coontail population must be reduced, along with the Eurasian watermilfoil population.

6.0 Vegetation Management goals and Objectives

The following management goals have been established by the IDNR for all Indiana lakes, including those applying for LARE funding. Any management practices implemented on Shipshewana Lake are to directly facilitate the achievement of these three goals:

1. Develop or maintain a stable, diverse aquatic plant community that supports a good balance of predator and prey fish and wildlife species, good water quality and is resistant to minor habitat disturbances and invasive species.

2. Direct efforts to preventing and/or controlling the negative impacts of aquatic invasive species.

3. Provide reasonable public recreational access while minimizing the negative impacts on plant and wildlife resources.

Specific Objectives:

Specific objectives are needed to ensure that the fundamental goals of the LARE program are met. The following steps are recommended to help achieve LARE management goals for Shipshewana Lake.

1. **The entire lake will be treated with Fluridone for the control of Eurasian Watermilfoil**. Eurasian milfoil is widely spread throughout the entire lake. In order to ensure effective control of the milfoil, the whole lake must be treated. Reducing the population of Eurasian milfoil in areas where it has already gained a foothold will provide multiple benefits, but will come with risks as well.

2. **Extra fluridone may be added to the Eurasian Watermilfoil treatment for the partial control of coontail at the lake association's expense**. Coontail is not an exotic species, and coontail treatments are not eligible for LARE funding. Eurasian watermilfoil can be controlled by fluridone at a concentration of 6 parts per billion (ppb), while the concentration needed to control coontail is 8 ppb.

2. **Vegetation surveys should be conducted to evaluate the effectiveness of the management plan.** A Tier II vegetation survey should be conducted after the herbicide treatment to evaluate its effectiveness. This survey should take place late in the growing season, as fluridone will take 90 to 120 days to achieve control of the Eurasian watermilfoil.

7.0 Past Management Efforts

In 2006, approximately 15 acres of Shipshewana Lake were treated with 2, 4-D to alleviate severe matting of Eurasian watermilfoil and coontail in the south end of Shipshewana Lake. This treatment area was located inside the problem plant area outlined in yellow in figure 3. This dense plant bed was nearly cutting the lake in half, making it extremely difficult for a boat to travel from the public access site to the north end of the lake. This treatment was sponsored by the LARE program and the lake association to provide some temporary relief until a larger management strategy could be developed.

Before this treatment no whole lake management strategy had been fully developed, and chemical treatments were limited to contact herbicides applied along lake frontages at the request of property owners. These treatments have been very limited. One area treated on a regular basis is the beach area for the Brethren Camp on Shipshewana Lake. Other treatments are very sporadic and usually only involve 50-100 feet of frontage. The management strategy in this plan should provide better control on a larger scale and improve recreational access to Shipshewana Lake.

8.0 Aquatic Plant Community Characterization

All lake management plans submitted for LARE funding must be accompanied by lake-wide aquatic vegetation surveys. These surveys are used to ensure that the plant community of the entire lake is adequately characterized. They provide information about the overall structure of the plant community, and describe species distribution and abundance in detail.

Two surveys are conducted on each lake in the first year it is involved in the LARE program. One survey is conducted in the spring and another is conducted later in the summer. This two-survey process is essential in providing an accurate representation of all plant species in a lake. Some species such as eel grass (*Vallisneria americana*) are not prevalent until summer and may be under-represented if only one survey was conducted in the spring. Other species such as curly-leaf pondweed (*Potamogeton crispus*) are prevalent in the spring and die off in the summer. This species would be under-represented if only one survey was conducted in the summer. Because of the diverse life cycles of different plants, multiple surveys increase the chance of accurately representing all of the species in a lake

Tier I and Tier II survey protocols have been established by the IDNR to ensure that each lake is surveyed in the same manner. These surveys reduce subjectivity and provide a consistent basis for the evaluation of a lake's plant community from year to year, as well as a basis for comparing the plant communities of different lakes. They provide quantifiable results that are vital for monitoring the success of management programs. In short, these vegetation surveys are the foundation for describing an aquatic plant community and proposing an effective management strategy.

8.1 Methods

This section provides an overview of the purpose and procedures behind the Tier I and Tier II vegetation surveys. The common goal of these surveys is to accurately describe the aquatic plant community of any particular lake. Standard procedures are established to ensure that:

1. The same survey procedures are used for each lake applying for funding.

2. Subjectivity is kept to a minimum to maintain scientific integrity.

3. The sample size for each survey adequately describes the plant community.

4. All data from each lake is recorded and analyzed in the same format.

In short, procedural and analytical consistency makes data from different surveys suitable for comparison and evaluation, while increasing its reliability and overall utility for evaluating the health of a plant community.

The Tier I survey involves finding and identifying the major plant beds in the lake. In lakes with high water clarity, this can be accomplished visually. In lakes with low water clarity, a rake may be lowered into the water to collect plants and identify areas of abundant plant growth. The composition of each major plant bed is then recorded.

The Tier II survey involves using a specially designed rake to collect plants from numerous sites throughout the entire lake. At each site, each species found is recorded, and given an abundance rating based on the amount collected.

These protocols are currently being used by IDNR fisheries biologists to describe the plant communities of Indiana lakes. They are accepted as practical ways describe a plant community in detail and provide quantifiable evidence as to the overall health of an ecosystem. For these reasons, the following surveys are being used to describe plant communities in all lakes applying for LARE funding.

8.1.1 Tier I

The Tier I reconnaissance survey is designed to identify the major plant beds present in a body of water. This is a qualitative survey designed to give an overview of the aquatic vegetation present in a lake. It identifies and documents problem areas that can be targeted when management practices are implemented. Major submersed plant beds are found visually from a boat. Each bed is given a reference number that is recorded on Tier I data sheets. The general location of these beds are recorded on a bathymetric map of the lake, and more precise locations are recorded on Tier I data sheets with the help of a WAAS enabled GPS unit.

When a major plant bed is identified, each species of plant found in that bed is recorded. Canopy ratings are given to each plant bed based on the types of plants present in that bed. The four major types of plants to be identified in this study are as follows: submersed plants, emergent plants, non-rooted floating plants and rooted floating plants. The following scale is used to describe these four types of plants based on the percentage of the plant bed canopy they occupy:

Canopy Rating
1 = < 2% of canopy
2 = 2-20%
3 = 21-60%
4 = >60% of canopy

In addition to the canopy rating, another abundance rating is given to each individual species found in a particular plant bed. This abundance rating is based on the percentage of the entire bed area that species appears to occupy. The scale for this abundance rating is the same as the canopy rating scale. The difference is that this scale identifies the abundance of *individual species* in the bed:

Species Abundance Rating
1 = < 2% of the bed
2 = 2-20%
3 = 21-60%
4 = >60% of the bed

http://dipin.kent.edu

Secchi disk readings are taken prior to the vegetation surveys. Secchi are plate-like objects used to measure water clarity. The disk is lowered into the water until it disappears. Once it has disappeared, it is then raised slightly until it is just barely visible. At this point, marked points on the secchi rope are used to determine the maximum depth at which the disk can be seen. In lakes with clear water, the Tier I survey is primarily a visual survey, in lakes with low water clarity, rake throws and the use of electronics help to locate and describe plant beds. The Tier I survey is a valuable tool that helps to provide an overall picture of an aquatic plant community when coupled with the Tier II quantitative survey.

8.1.2 Tier II

The purpose of Tier II surveys is to document the distribution and abundance of submersed and floating-leaved aquatic vegetation throughout a lake (IDNR, 2004). A specific number of sample sites are selected based on the amount of surface acreage the lake possessed. Once sample sites are determined, sampling is accomplished using an aquatic vegetation sampling rake constructed according to the guidelines of the 2006 Tier II random sampling procedure manual.

Aquatic vegetation collected at each sample site is sorted according to species, and given a value to represent its abundance at that site. These values are recorded on data sheets distributed by the IDNR. These records are used for data analysis that served to characterize the aquatic vegetation community of Shipshewana Lake.

Random Sampling:

The Tier II survey protocol was changed by the IDNR in 2006. New LARE Tier II protocol requires that sample sites be stratified by depth contour. Prior to 2006 sites were to be spaced evenly through the littoral zone.

Before 2006, the number of sample sites required each lake were determined strictly by lake size. In the 2006 protocol, the number of sample sites needed is based on both lake size and trophic state. Trophic state describes the productivity of a lake and is correlated with plant growth, secchi disk, and nutrient availability. There are 4 different trophic states listed by the IDNR: Oligotrophic, Mesotrophic, Eutrophic, and Hypereutrophic. Oligotrophic Lakes usually have clear water and few nutrients, while Hypereutrophic lakes usually have deeply stained water and are nutrient rich. Table 3 is taken from the IDNR 2006 Tier II protocol and shows the maximum depth that must be sampled for a lake in each trophic state. In oligotrophic lakes, where water is clear, plants may be able to grow in up to 25 feet of water because sunlight may still reach the lake bottom in deep water. In hypereutrophic lakes where water is turbid, lack of sunlight will prevent plants from growing in deep water, so the maximum sampling depth is only 10 feet.

Table 3: Sample Depth by Trophic State

Trophic State	Maximum Depth of Sampling (ft)
Hypereutrophic	10
Eutrophic	15
Mesotrophic	20
Oligotrophic	25

Table 4 is used to calculate the number of sample sites need in each depth contour by using lake size and trophic status. The new protocol attempts to more accurately describe the entire littoral zone of a lake and provide more detailed data analysis by separating the littoral zone into 5 foot depth segments.

Table 4: Sample Sites by Lake Size and Trophic State

Tier II Sampling 3

Table 3. Sample size requirements as determined by lake size, trophic state, and apportioned by depth class.

		Hypereutrophic		Eutrophic			Mesotrophic				Oligotrophic				
Lake Acres	Total # of Sites	0-5 foot contour	5-10 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	15-20 foot contour	0-5 foot contour	5-10 foot contour	10-15 foot contour	15-20 foot contour	20-25 foot contour
<10	20	10	10	10	7	3	10	5	3	2	10	4	3	2	1
10-49	30	20	10	10	10	10	10	10	7	3	10	10	5	3	2
50-99	40	30	10	17	13	10	10	10	10	10	10	10	10	7	3
100-199	50	40	10	23	17	10	14	14	12	10	10	10	10	10	10
200-299	60	50	10	30	20	10	18	16	16	10	14	12	12	12	10
300-399	70	60	10	37	23	10	22	20	18	10	17	15	14	14	10
400-499	80	70	10	43	27	10	25	23	22	10	19	18	17	16	10
500-799	90	80	10	50	30	10	29	27	24	10	22	21	19	18	10
>=800	100	90	10	57	33	10	33	31	26	10	25	23	22	20	10

Based on Shipshewana Lake's 202 surface acres and its classification as hypereutrophic, 60 sample sites were needed to describe this plant community. Aerial photographs and bathymetric maps were used to evenly space the sample sites throughout the lake. The littoral zone of the lake was divided into four quadrants. During the vegetation collection process, an effort was made to collect plants from an equal number of sites in each quadrant to ensure that the entire littoral zone was surveyed adequately and that random sample sites distributed evenly throughout the lake.

Aquatic Vegetation Sampling Rake:

A double-headed garden rake was used to sample aquatic vegetation. This rake design is approved and used by IDNR fisheries biologists in vegetation surveys on many Indiana lakes. It consists of two garden rake heads welded together back to back so that rake teeth are protruding from two sides. The dimensions of the rake are to be 13.5 inches wide with 2.25-inch long teeth spaced 0.75 inches apart (IDNR, 2004).

Each tooth on the rake head is divided into five equal sections and marked accordingly. These marks on the rake teeth are used to estimate the abundance of plant species when they are collected.

A nylon rope is then attached to the rake head. A black permanent marker is used to mark the rope in foot long increments. A red mark is placed every five feet along the rope. This rope is used to measure the depth at each sample site when the rake is lowered to the lake bottom.

GPS and Mapping:

A WAAS enabled GPS unit was used to obtain and record the coordinates of each sample site on the lake. A WAAS enabled GPS unit is accurate to within 3 meters and was recommended to obtain maximum accuracy for mapping sample sites. All GPS coordinates were then used to produce computer generated maps of the lake with each sample site labeled on the map.

Sampling Procedure

A two-person crew accomplished Tier II aquatic vegetation sampling by boat. A crew leader was responsible for driving the boat to each sample site and recording vegetation data on record sheets issued by the IDNR. An assistant was responsible for collecting the aquatic plants using the double-headed rake.

When a sample site was reached, its GPS coordinates were obtained and recorded. The boat was then brought to a complete stop and the double-headed rake was lowered to the bottom of the lake. The boat was held stationary while the water depth at the sample site was obtained by using the marked rope attached to the rake. When water depth had been recorded, the crew leader slowly backed the boat away from the rake as the assistant simultaneously let out another ten feet of rope. During this process the rake did not move from the lake bottom.

The rake was pulled from the water after the boat had reached the end of the ten extra feet of rope let out after the depth was recorded. This ensured that the rake was pulled horizontally through the water, giving it a greater chance of collecting weeds than if the rake had been lowered to the bottom and raised vertically. The vegetation caught on the teeth of the rake was then gathered into the boat.

Determining Vegetation Abundance

At each sample site, every plant species collected on the rake was scored according to its abundance. This was accomplished by removing all plants from the rake and sorting them by species. Once all plants had been sorted, they were placed back onto the rake and evenly distributed across the marks on the rake teeth. If a species filled the rake to the first mark on the teeth, that species was given a score of 1 on the abundance data sheet. If it filled the rake teeth to the second mark, it was given a score of 2, and so on to a maximum abundance of five. In many instances it was not necessary to place each species back onto the rake. Many species would fill the rake completely (an abundance of 5) and some species would only have one plant on the rake (an abundance of 1). In addition to abundance scores for individual species, each rake toss was given an overall abundance score, describing how much total vegetation was collected on the rake.

8.1.3 Analytical Methods

One of the methods used to analyze the Tier II data was an IDNR Vegetation Database. Survey data was imported from Microsoft Excel and used to calculate plant community metrics that describe the plant community of a lake. This program and these metrics are used by biologists throughout the state and provide consistency in data analysis procedures. This consistency makes Tier II data more useful for comparisons between lakes and from year to year.

Delorme X-Map 4.5 was used to map major plant beds and individual species distributions. To map individual species, GPS coordinates representing each sample site where the species was collected were imported into the program and displayed on a computer generated map of the lake. For major submersed plant beds and emergent plant beds, a bathymetric map of the lake was imported into the program and geo-referenced to ensure greater accuracy for the locations of plant beds. A combination of GPS coordinates, landmarks, field notes, and the bathymetric map helped to estimate the exact locations of each plant bed. Estimates of plant bed sizes were calculated using X-Map after each bed was drawn on the bathymetric map.

8.2 Results

8.2.1 Tier I Results

Tier I surveys were conducted on Shipshewana Lake on May 17, 2006 and August 2, 2006. The submersed plant community of Shipshewana Lake covers roughly 114 acres of the lake, or 56% of the lake's total surface area. Secchi disk readings can vary from 2 to 5 feet depending on time of year and algal blooms. Plants are usually not found in water deeper than 8 feet during mid to late summer.

Coontail and Eurasian watermilfoil are the two dominant plants in Shipshewana Lake, with Eurasian watermilfoil being dominant in early spring, and coontail becoming dominant as the summer progresses. Eurasian watermilfoil experiences a natural die off during late summer. Although reasons for this are not clear, rising water temperature and algal blooms likely contribute to this population decline. During the August survey, surface temperatures on Shipshewana Lake ranged from 87 to 9l degrees Fahrenheit.

Problem Plant Areas:
Significant impairment of the lake occurs in roughly 52 acres in plants beds #1 and #5. Although the entire lake is infested with Eurasian watermilfoil, the most significant recreational impairment occurs in plant bed #1 on the 2006 submersed plant bed map. Matted vegetation (coontail and EWM) collect in this shallow bed and cut the lake in half, making boat travel difficult to impossible in this area of the lake. Filamentous algae growth flourishes on this plant bed as well, further inhibiting recreation in this area.

Beneficial Plant Areas:

On of the most beneficial plant areas on Shipshewana Lake is the large wetland area along the north shore of the lake. This is area is undeveloped, and should be protected to prevent a further decline in water quality. This area is estimated at 38 acres. There are also other small

wetland areas around the shoreline of Shipshewana Lake that should be protected as well to provide shoreline stabilization and nutrient uptake.

Areas of native vegetation other than coontail are scarce. Sago Pondweed is the main native plant in the lake besides coontail, and is not dominant in any of the plant beds. Table 5 summarizes composition of the major plant beds in Shipshewana Lake.

Table 5: 2006 Tier I Submersed Plant bed Summary

Shipshewana Lake 2006 Tier I Submersed Plants

Species Abundance by Plant Bed #

	#1	#2	#3	#4	#5
Plant Species					
Eurasian Watermilfoil	2	3	3	3	3
Duckweed				1	2
Sago Pondweed	1		1		2
Curly-Leaf Pondweed				2	
Coontail	3	3	3	2	3
Total # of Species	**3**	**2**	**3**	**4**	**4**
Size (Acres)	*41*	*16*	*1*	*45*	*11*

Species Abundance Ratings

1 = < 2% of the bed
2 = 2-20%
3 = 21-60%
4 = >60% of the bed

Plant Bed #1

Size: 41 acres
Substrate: Silt/Clay
Number of Species: 3
Description: This plant bed is the most dense plant bed in the lake. Eurasian watermilfoil and coontail are the dominant species. This plant bed forms a large mat on the surface of the lake that makes any kind of recreation very difficult in this area of the lake. Sago pondweed was also found in the bed, although its abundance is not problematic.

Plant Bed #2

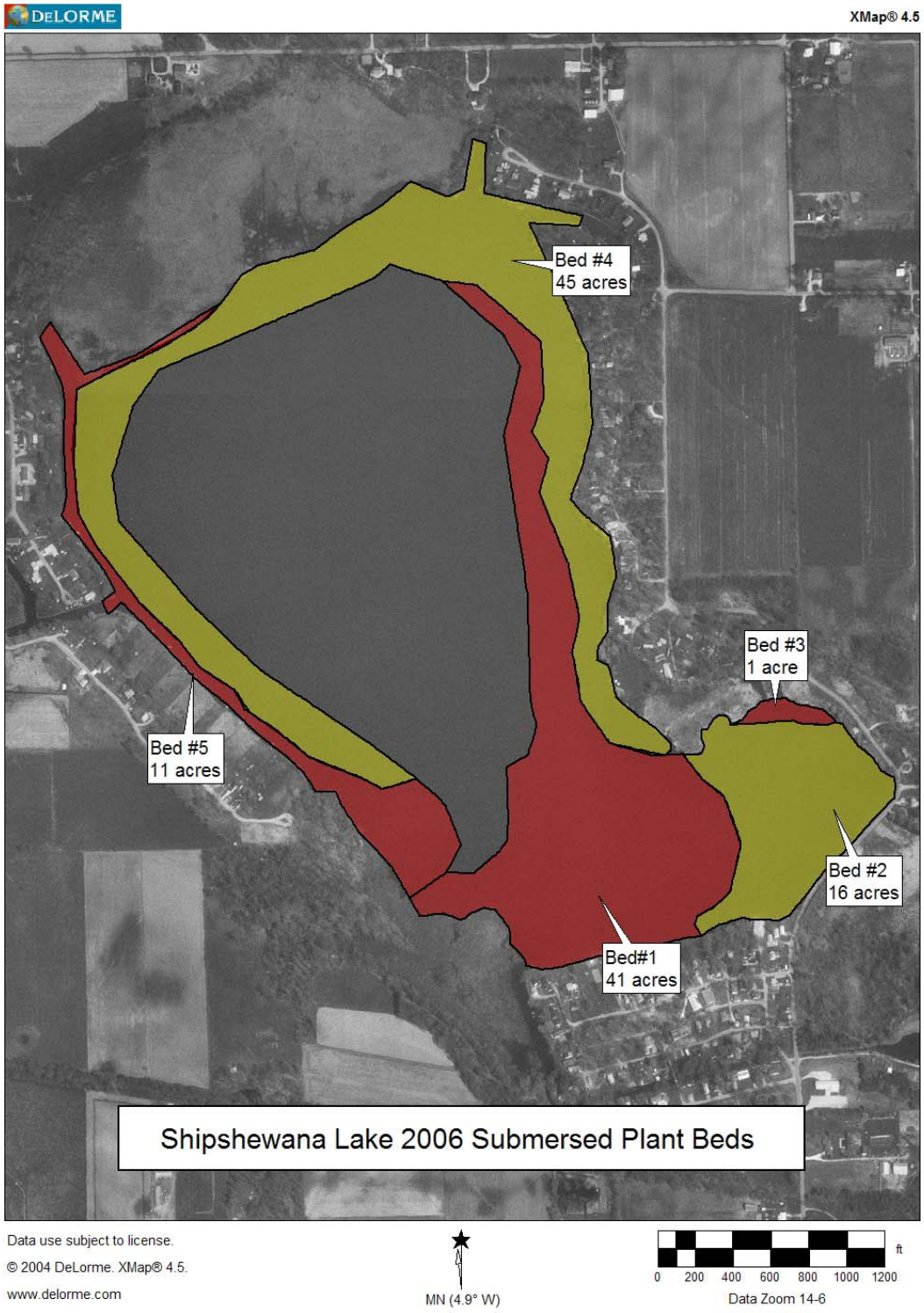
Size: 16 acres
Substrate: Silt/Clay
Number of Species: 2
Description: This plant bed is located in the southeast bay of the lake. Although plant growth is abundant in this bed, it is generally not matted on the surface, with the exception of wind blown shorelines where cut vegetation collects. Coontail and Eurasian watermilfoil were the only two plants found in this plant bed.

Plant Bed #3
Size: 1 acre
Substrate: Silt/Clay
Number of Species: 3
Description: This small plant bed is located along the wetland area in the southeast bay of the lake. Three plant species were found in this bed. Eurasian watermilfoil was slightly more abundant that coontail in spring, and coontail was dominant by August of 2006. Sago pondweed was also found in this bed in low abundance.

Plant Bed #4
Size: 45 acres
Substrate: Silt/clay
Number of Species: 4
Description: This is the largest plant bed in the lake at 45 acres. It is also one of the most diverse, containing 4 plant species. It covers a large portion of the north shore of the lake. Coontail was dominant in this bed, followed closely by Eurasian watermilfoil. Duckweed is found in this plant bed in pockets of matted vegetation and along the shoreline, while curly lea pondweed was also present in the spring, with low to moderate abundance.

Plant Bed #5
Size: 11 acres
Substrate: Silt/Clay
Number of Species: 4
Description: This near shore plant bed is located along the west shoreline of the lake. Four plant species were found in this bed. In spring of 2006, Eurasian watermilfoil was by far the dominant species, although coontail had become dominant by August of 2006. Duckweed and Sago pondweed were also found in this plant bed in much lower abundance.

Figure 4: Shipshewana Lake Submersed Plant Beds



Shipshewana Lake's emergent plant community covers an estimated 51 acres in areas adjacent to the lake. The majority of this acreage is located along the north shore of Shipshewana Lake (emergent bed #3). Other small wetland areas are disbursed along the shoreline of the lake. The following table summarizes the results of the Tier I emergent plant survey.

Table 6: 2006 Tier I Emergent Plant Bed Summary

Shipshewana Lake 2006 Tier I Emergent Plant Beds

Species Abundance by Plant Bed #

	#1	#2	#3	#4	#5
Plant Species					
Arrowhead	1	1			2
Spatterdock	3	2	3	3	3
Soft-stem Bulrush	1	1			
Cattail	2	3	2		2
Iris sp.		1	1		
White Lilly		2	1	2	2
Duckweed		1	1		
Watermeal		1	1		
Willow sp.		1			
Total # of Species	**4**	**9**	**6**	**2**	**4**
Size (Acres)	*0.75*	*4.5*	*38*	*7*	*1.75*

Emergent Bed #1
Size: 0.75 acre
Substrate: Silt/Clay
Number of Species: 4
Description: This small emergent bed is located along the south shore of the lake near the outlet. Spatterdock and cattails were the most common plants, although soft stem bulrush and arrowhead were present in low abundance as well.

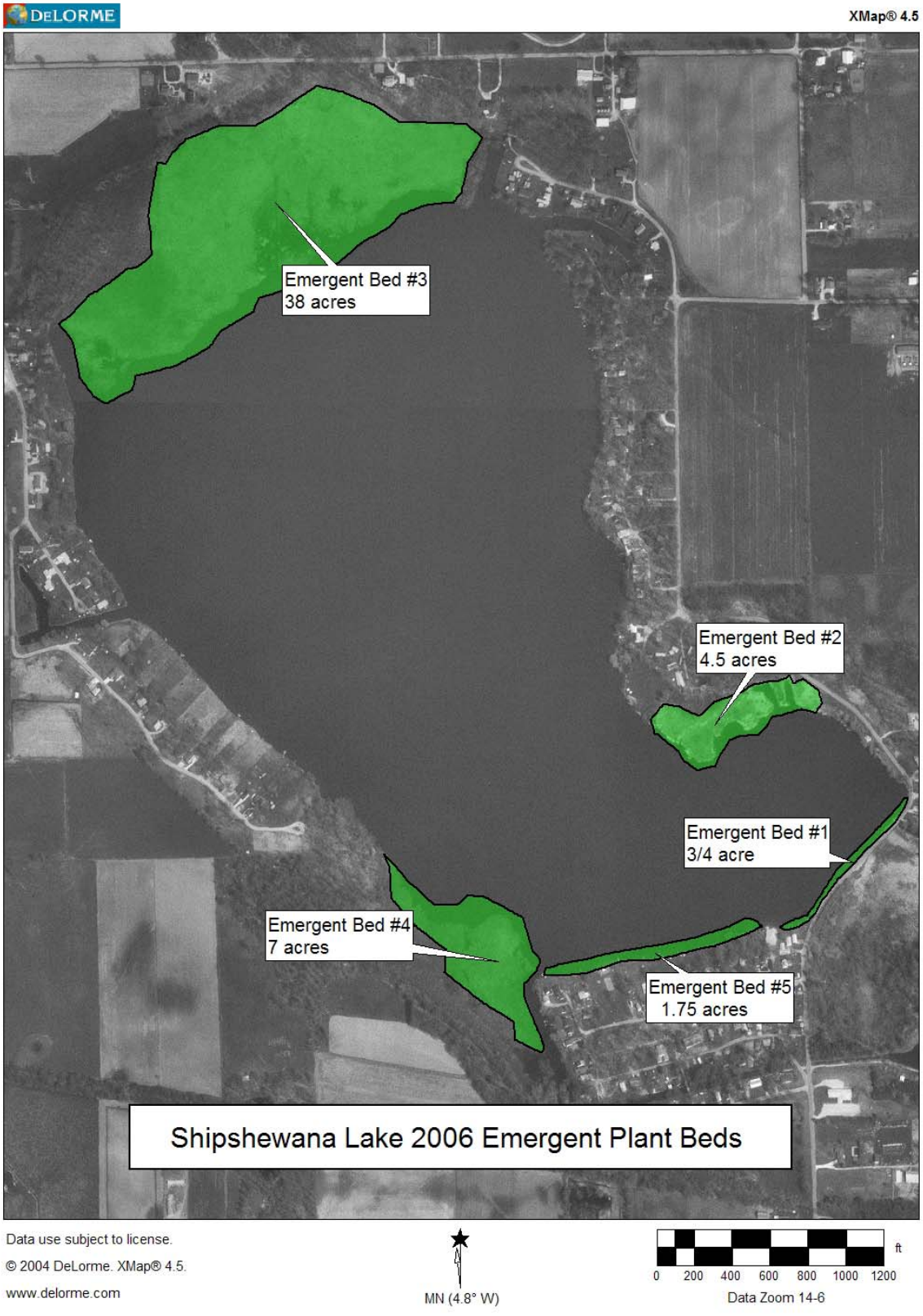
Emergent Bed #2
Size: 4.5 acres
Substrate: Silt/Clay
Number of Species: 9
Description: This plant bed was the most diverse wetland area in the lake containing 9 plant species. Cattails and spatterdock were common in the water and Iris and willow species were observed on the shoreline. Duckweed and watermeal were floating in pockets between cattails and spatterdock.

Emergent Bed #3
Size: 38 acre
Substrate: Silt/Clay
Number of Species: 6
Description: Emergent Bed #3 is the largest wetland area around Shipshewana Lake. It is estimated at 38 acres and contains 6 different plant species. Spatterdock and cattail are dominant in the near shore zone, although white lily was present in low abundance as well. Willow and Iris species were observed on the shoreline, and duckweed and watermeal were again present in pockets between spatterdock and cattails.

Emergent Bed #4
Size: 7 acres
Substrate: Silt/Clay
Number of Species: 2
Description: This wetland area is located in the southwest corner of the lake. It is 7 acres, and Cattails and spatterdock are again the dominant species in this emergent plant bed. Iris and willow species are supposed to be present in the very thick area away from the lake, although this area is innavigable.

Emergent Bed #5
Size: 1.75 acres
Substrate: Silt/Clay
Number of Species: 4
Description: This emergent plant bed runs along much of the south shore of the lake just west of the IDNR's public access site. Spatterdock is the dominant plant in this bed, although white lily, cattails and arrowhead are all present in lower abundance.

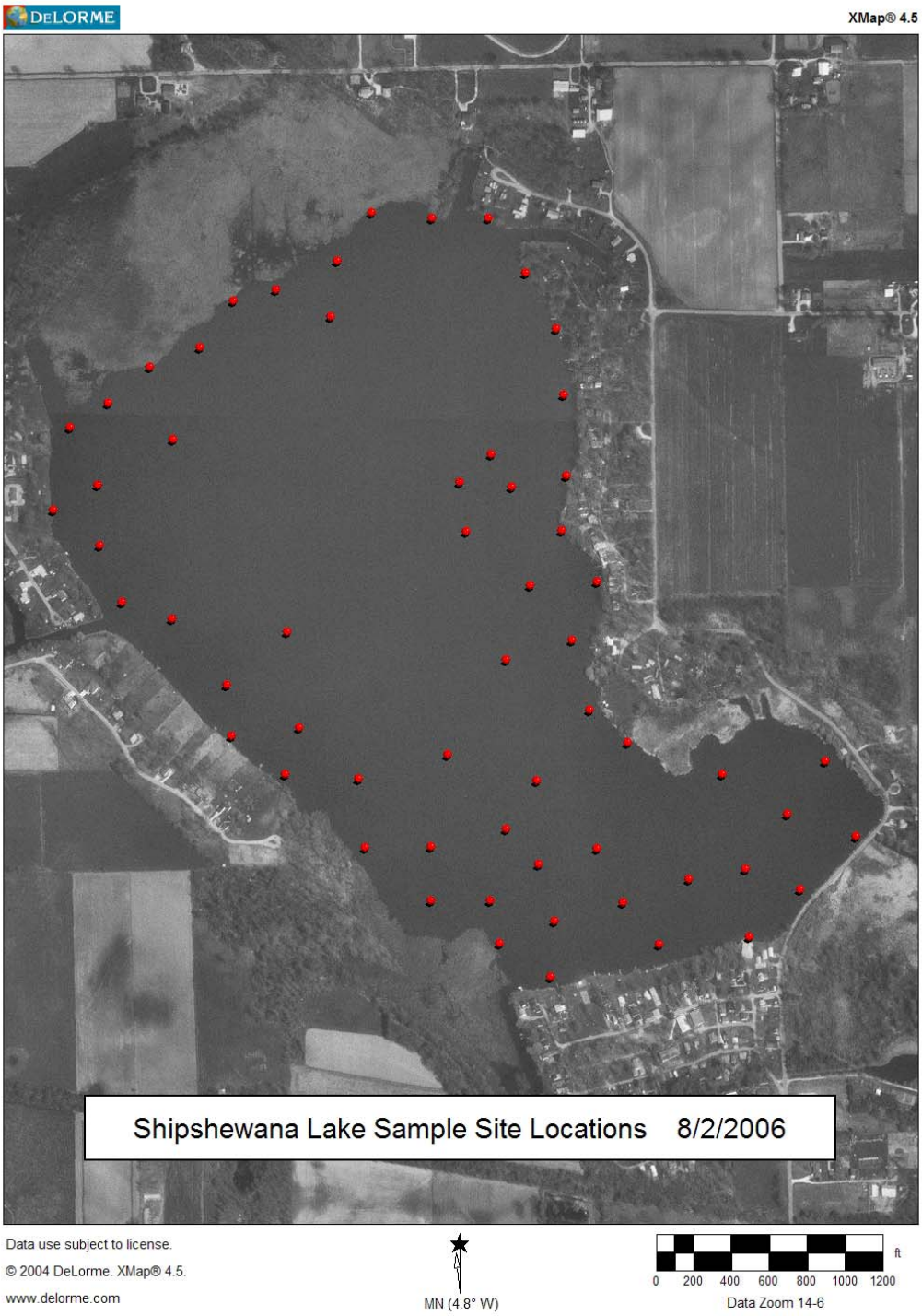
Figure 5: Shipshewana Lake Emergent Plant Beds



8.2.2 Tier II Results

Secchi depth was estimated at 2.5 feet in the 2006 Tier II survey. Sixty rake samples were distributed throughout each 5 foot depth contour of the littoral zone. A total of 4 species of submersed aquatic plants were collected during this survey. Eurasian watermilfoil was the only invasive plant found in this survey. The following map shows the locations of all sample sites during the 2006 Tier II survey.

Figure 6: Shipshewana Lake Tier II Sample Site Locations



August Data Analysis

Tables 7 through 9 are data summaries for the 2006 aquatic vegetation survey. These tables help to describe the plant community, and will help identify any changes that take place in the years to come. Table 7 includes every sample site, while tables 8 and 9 describe each depth contour of the lake's littoral zone (0-5 feet, 5-10 feet, etc).

Table 7: Fall 2006 Data Analysis: All Sites

Occurrence and Abundance of Submersed Aquatic Plants

Date:	8/2/06	Littoral sites with plants:	54	Species diversity:	0.56
Littoral depth (ft):	10.0	Number of species:	4	Native diversity:	0.24
Littoral sites:	60	Maximum species/site:	3	Rake diversity:	0.37
Total sites:	60	Mean number species/site:	1.55	Native rake diversity:	0.09
Secchi:	2.5	Mean native species/site:	1.00	*Mean rake score:	3.83

Common Name	Site frequency	Rel. Freq.	Relative density	Mean density	Dominance
Coontail	86.7	55.9	3.43	3.96	68.7
Eurasian Watermilfoil	55.0	35.5	0.88	1.61	17.7
Sago Pondweed	11.7	7.5	0.15	1.29	3.0
Leafy Pondweed	1.7	1.1	0.02	1.00	0.3

Table 8: Fall 2006 Data Analysis: 0 - 5 Foot Depth Contour

Occurrence and Abundance of Submersed Aquatic Plants

Date:	8/2/06	Littoral sites with plants:	48	Species diversity:	0.57
Littoral depth (ft):	5.0	Number of species:	4	Native diversity:	0.26
Littoral sites:	49	Maximum species/site:	3	Rake diversity:	0.38
Total sites:	49	Mean number species/site:	1.73	Native rake diversity:	0.09
Secchi:	2.5	Mean native species/site:	1.10	*Mean rake score:	4.33

Common Name	Site frequency	Relative density	Mean density	Dominance
Coontail	93.9	3.92	4.17	78.4
Eurasian Watermilfoil	63.3	1.00	1.58	20.0
Sago Pondweed	14.3	0.18	1.29	3.7
Leafy Pondweed	2.0	0.02	1.00	0.4

Table 9: Fall 2006 Data Analysis: 5 -10 Foot Depth Contour

Occurrence and Abundance of Submersed Aquatic Plants

Date:	8/2/06	Littoral sites with plants:	5	Species diversity:	0.28
Littoral depth (ft):	10.0	Number of species:	2	Native diversity:	0.00
Littoral sites:	10	Maximum species/site:	2	Rake diversity:	0.15
Total sites:	10	Mean number species/site:	0.60	Native rake diversity:	0.00
Secchi:	2.5	Mean native species/site:	0.50	*Mean rake score:	1.30

Common Name	Site frequency	Relative density	Mean density	Dominance
Coontail	50.0	1.10	2.20	22.0
Eurasian Watermilfoil	10.0	0.10	1.00	2.0

No plants were collected in the 10 -15 foot depth contour

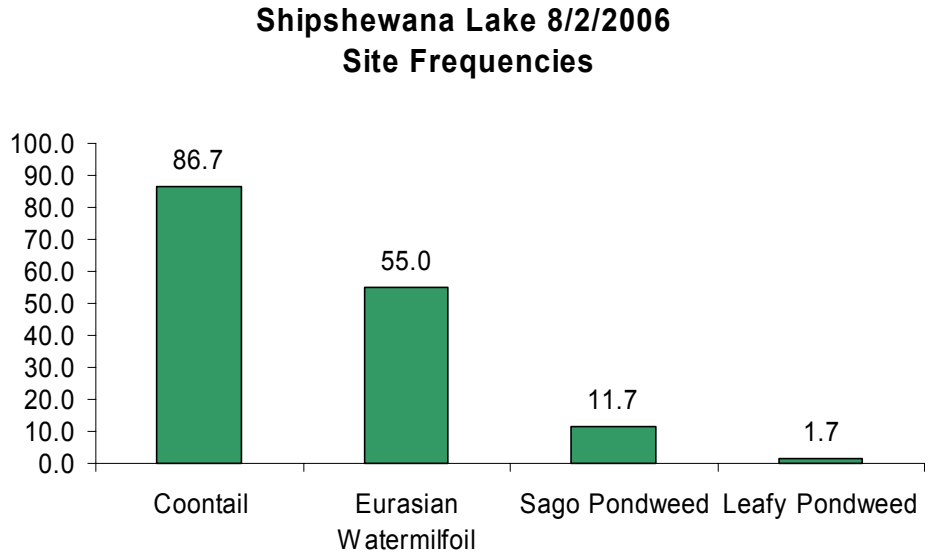
Site Frequency

Site frequency is a measure of how often a species was collected during the Tier II survey. It can be calculated by the following equation:

$$\text{Site Frequency} = \frac{(\text{\# of sites where the species was collected})}{\text{Total \# of littoral sample sites}} \times 100$$

Table 10 shows site frequencies for every plant collected in August 2006. Coontail was by far the most commonly collected plant in the survey with a site frequency of 86.7%. Eurasian watermilfoil was second with a site frequency of 55%. Sago pondweed had a site frequency of 11.7% and leafy pondweed had a site frequency of only 1.7%.

Table 10: 2006 Tier II Site Frequencies



Mean Density and Relative Density

Mean Density is a measure the abundance of a species in areas where it is growing. For example, a species can have a high site frequency, but still have a very low mean density. This means that a species may be prevalent throughout an entire lake, but it may also be sparsely scattered. Mean density can be calculated using the following equation:

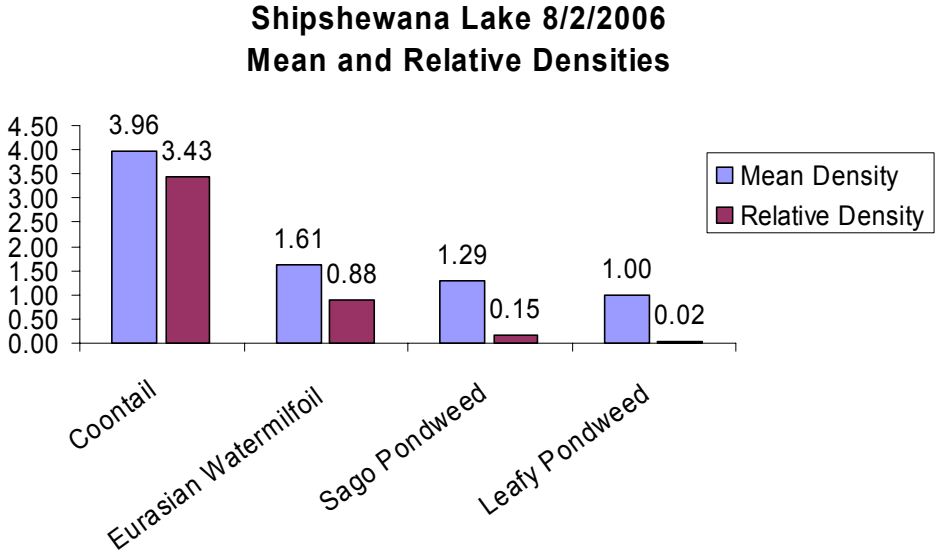
$$\text{Mean Density} = \frac{(\text{The sum of all rake scores for a species})}{(\text{Total \# of sites where the species was collected})}$$

Relative Density is calculated much like mean density, only in this case, the sum of the rake scores for a species is divided by the total number of sample sites in the survey. Unless a species was collected at every sample site, the relative density will always be smaller than the mean density.

$$\text{Relative Density} = \frac{(\text{The sum of all rake scores for a species})}{(\text{Total \# of littoral sample sites})}$$

Table 11 shows mean and relative densities for each plant found in the August 2006 Tier II survey. Coontail had both the greatest mean density and the greatest relative density at 3.96 and 3.43 respectively. Eurasian watermilfoil was second with values of 1.61 and 0.88 respectively. Sago pondweed's mean density was similar to Eurasian watermilfoil, but its relative density was much lower because it was not frequently collected.

Table 11: 2006 Tier II Mean and Relative Densities



Species Diversity

The species diversity indices listed in tables 7 through 9 help to describe the overall plant community. A species diversity index is actually measured as a value of uncertainty (H). If a species is chosen at random from a collection containing a certain number of species, the diversity index (H) is the probability that a chosen species will be different from the previous random selection. The diversity index (H) will always be between 0 and 1. The higher the H value, the more likely it is that the next species chosen from the collection at random will be different from the previous selection (Smith, 2001). This index is dependent upon species richness and species evenness, meaning that species diversity is a function of how many different species are present and how evenly they are spread throughout the ecosystem.

The overall species diversity index for Shipshewana Lake in August 2006 was 0.56 which is low when compared to other Indiana lakes. Native plant diversity in August of 2006 was very low at 0.24, meaning that an invasive species (Eurasian watermilfoil) accounted for some of the diversity in Shipshewana Lake. Rake diversity and native rake diversity were measured at 0.37 and 0.09 respectively in August 2006.

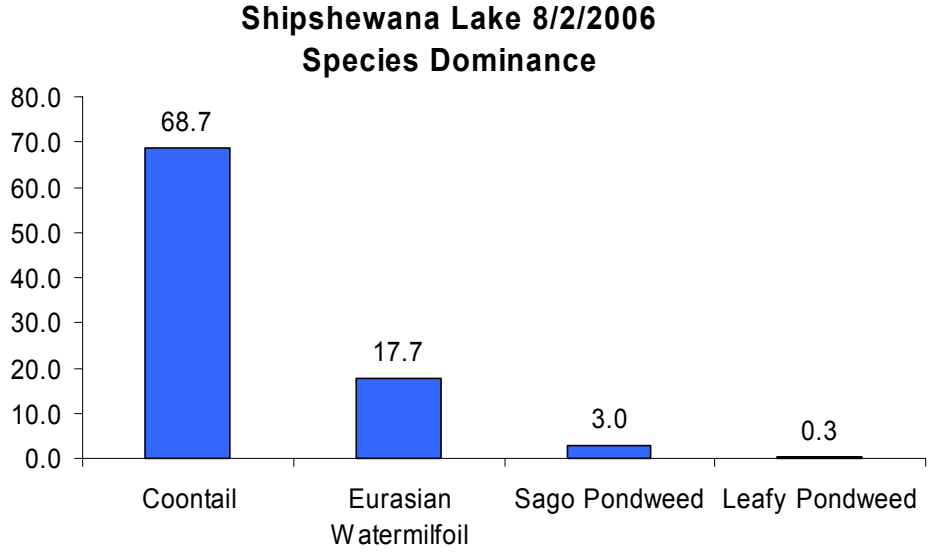
Species Dominance

Species dominance is dependent upon how many times a species occurs, and its relative coverage area or biomass within the system. In this survey, the abundance rating given to each species at each sample site was used to determine dominance. The dominance of a

particular species in this Tier II survey increases as its site frequency and relative abundance increase.

Table 12 tracks dominance values for each plant collected at Shipshewana Lake during the August 2006 survey. Trends are similar to sight frequency, with coontail being by far the most dominant plant in the fall survey. Eurasian watermilfoil was second, followed by sago pondweed and leafy pondweed.

Table 12: 2006 Tier II Dominance Values



Relative Frequency of Occurrence

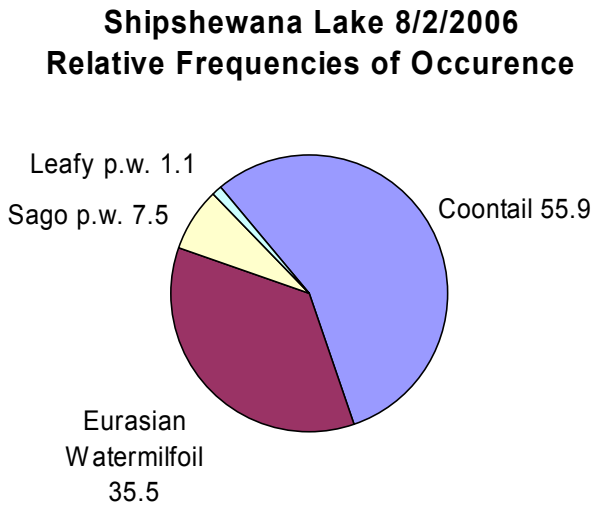
Relative frequency of occurrence is a measure of how often a plant is collected in relation to all of the other plants collected in a Tier II survey. It is demonstrated with the following equation:

$$\text{Relative Freq. of Occurrence} = \frac{\text{The site Frequency for a species}}{\text{The sum of all site frequencies including the species in question}} \times 100$$

The sum of all relative frequency of occurrence values will always add up to 100. For this reason it is displayed in a pie graph.

Table 13 shows relative frequency of occurrence values for each plant collected in the fall 2006 survey. Coontail had the greatest relative frequency at 55.9. Eurasian watermilfoil was second at 35.5, sago pondweed was third at 7.5 and leafy pondweed was last 1.1.

Table 13: 2006 Tier II Relative Frequencies of Occurrence



8.3 Macrophyte Inventory Discussion

Submersed aquatic vegetation covers an estimated 114 acres, or 56% of Shipshewana Lake's total surface area. Significant wetland areas cover approximately 51 acres, both in and around the lake. Every submersed plant bed in the lake has high abundances of both coontail and Eurasian watermilfoil.

Based upon 2006 survey data, Shipshewana Lake has a very low diversity of submersed aquatic plant community when compared with many area lakes. Species richness in Shipshewana Lake was low with only 4 submersed species collected in August of 2006. Eurasian milfoil is unquestionably a major problem in the lake, as it was the most dominant plant in the May 2006 survey and the second most dominant plant in the August 2006 survey.

As more data is collected in the years to come, long term trends can be identified, and the health of the plant community can be more closely tracked. One of the most obvious trends in the 2006 data was a change in plant dominance from spring to fall. Coontail replaces Eurasian watermilfoil as the dominant species as summer progresses, and causes recreational problems in summer and fall.

In summary, the Shipshewana Lake is characterized by low plant diversity, low water clarity and quality, and an overabundance of Eurasian watermilfoil and coontail.

9.0 Aquatic Plant Management Alternatives

Shipshewana Lake currently has dense beds of Eurasian milfoil in many areas of the lake. Eurasian milfoil is believed to have arrived in North America in the mid 1940's and has spread throughout the east coast to northern Florida and the Midwest. Eurasian milfoil spreads by fragmentation and seed dispersal, and it has the ability to over-winter from year to

year. Once it is in a lake it can become the dominant plant species because it forms dense canopies which shade out the native, more beneficial plant species below. There is also increasing evidence that mat forming species like Eurasian milfoil and curly leaf pondweed exert significant negative impacts on a broad range of aquatic organisms (Pullman, 1998)

Many management strategies have been used to control Eurasian milfoil in Indiana lakes. A management strategy should be chosen based on its selectivity of the pest in question, its long term effectiveness, and its environmental risks, The main goal of this plan is to choose a management option that can effectively control the Eurasian watermilfoil with little or no environmental risk, while causing no harm to native plant or fish species.

9.1 No Action

If no action is taken, the Eurasian milfoil abundance will increase from year to year. Eurasian milfoil grows by fragmentation, meaning that if the plant is cut, the fragment has the ability to form an entirely new plant. Eurasian milfoil also over-winters as an adult plant so new generations are created in each growing season. These reproductive characteristics cause milfoil beds become more dense over time, which can create a monoculture as it may eliminate more and more native species from a lake.

9.2 Institutional-Protection of Beneficial Vegetation

Lake users can play an important role in the protection of beneficial aquatic vegetation. Aquatic invasive species often gain a foothold in an ecosystem in areas disturbed by human activity or natural processes. In many cases, boating may be restricted in certain areas of a lake to prevent harm to native plants, especially many emergent species. Boating lanes may be established through areas of emergent vegetations, and protected ecological zones may be created to prevent erosion off shoreline vegetation caused by intense wave action from boating activities. Shallow areas of a lake may also be marked with buoys to prevent injury to boats and boaters. It is important to obey boating restrictions to protect beneficial plant species and even prevent personal injury.

A healthy aquatic plant community is absolutely essential for the maintenance of a stable, diverse ecosystem. Aquatic plants provide habitat for plankton, insects, crustaceans, fish, and amphibians. They take nutrients like phosphorus and nitrogen out of the water column, increase water clarity, prevent harmful algal blooms, produce oxygen and provide food for waterfowl. Aquatic plants can even remove pollutants from contaminated water, and prevent the suspension of particulate matter by stabilizing sediment and preventing erosion from wave action or current.

The LARE aquatic vegetation management program recognizes the importance of beneficial aquatic vegetation and its protection is a top priority. The most basic goal for the LARE aquatic vegetation program is to maintain healthy aquatic ecosystems by maintaining or improving biodiversity in Indiana lakes. The purpose of conducting aquatic vegetation surveys is to document the overall health of plant communities and identify any ecosystem whose stability is threatened by invasive plant species.

Once a problem area is identified, a management strategy must be formulated that directly impacts the aquatic plant community in a positive way. While eradicating invasive plants is

a major component of many management strategies, it is important to note the ultimate goal is not to eradicate aquatic vegetation, but to protect beneficial vegetation and protect lake ecosystems.

9.3 Environmental Manipulation

9.3.1 Water Level Manipulation

Draw down of the lake water level is one option that may help the Eurasian milfoil problem. Lower water levels expose the Eurasian milfoil roots to freezing and thawing, which may kill may kill milfoil root systems. However, a lake draw down will not only kill Eurasian milfoil, but native plants as well. Also, reducing the lake level would make new areas of the lake available for vegetative growth, and Eurasian milfoil may have an advantage in the colonization of these new areas if it is not eradicated prior to the lake draw down. An IDNR permit is required for this practice.

9.3.2 Nutrient Reduction

Limiting factors for plant growth include light, lake morphometry and depth, substrate and the availability of nutrients like phosphorus and nitrogen. While lake morphometry is most highly correlated with plant biomass, the availability of phosphorus and nitrogen have a tremendous impact on the amount of plant growth in a body of water. If the vast majority of phosphorus in a system is tied up in plant matter, it may be difficult for an invasive species to gain a foothold and spread rapidly in the lake. If phosphorus is constantly being added to the system and is readily available in the water, then invasive species will have an unlimited food supply should a disturbance create the opportunity for them to proliferate in a body of water.

Phosphorus and nitrogen are added to aquatic systems by many natural sources, such as the decomposition of plant material, and animal waste, but human activity is often responsible for excessive phosphorus loading that contributes to blue-green algal blooms, overabundant vegetation growth and a general decline in water quality. Major contributions of excess phosphorus come from sources such as septic system inputs, agricultural runoff, storm water drainage, lawn fertilizer applications, , and improper disposal of grass clippings and tree leaves. Owners of lake front property can significantly reduce the amount of phosphorus entering the lake by taking actions outlined in the public education section.

www.epa.gov

9.4 Mechanical Controls

9.4.1 Mechanical Cutting and Harvesting

www.cleanlake.com

Mechanical harvesting uses a large machine to cut and collect unwanted aquatic plants. These machines pick up the cut weeds but will still leave small fragments that will have the ability to re-grow. Also, after an area is harvested the Eurasian milfoil generally re-grows first causing the native plants to be shaded out again. Mechanical harvesting is also not selective in its control. The harvesting will cut the native plant species as well as the exotics if both are present in the same area. For these reasons, mechanical harvesting is not recommended. Harvesting can be accomplished by individual owners around their dock areas. A lake property owner can legally harvest a 625 square foot area. (25 feet by 25 feet). An IDNR permit is required for an area larger than 625 square feet, or if is not conducted by the property owner.

9.5 Manual Controls

9.5.1 Hand Pulling, Cutting, Raking

www.ecy.wa.gov

Manual controls such as hand pulling, cutting and raking can be effective ways to control unwanted plants in certain situations. In very shallow clear water, small areas of vegetation can identified and cleared effectively by hand. Large areas of vegetation, especially those in deeper water can be extremely difficult to control using these methods. Many of the harvested weeds will break apart, leaving the root system in the lake bottom. Failure to remove root structures will result in re-growth.

Plants that possess the ability to reproduce through fragmentation can seldom be effectively controlled by these methods if they are distributed throughout a lake. Identifying every area of infestation would be difficult, as would harvesting the plants without causing fragmentation of individual plants. Any plant fragments not removed from the water can form new plants, meaning that hand pulling and cutting can facilitate the spread of the unwanted plant species.

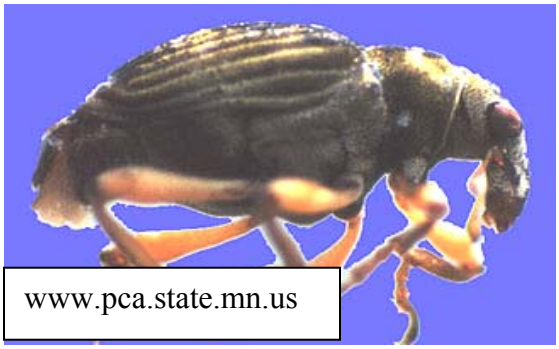
9.5.2 Bottom Barriers

Bottom Barriers prevent the growth of aquatic plants by lining the bottom of a lake or pond with a material that prohibits light from reaching the lake bottom and that is difficult for plants to penetrate. Many times, plastic or concrete barriers are used to prevent the growth of aquatic vegetation during construction of a lake or pond. This from of control is best implemented during construction of a new pond, and placing a bottom barrier in an existing lake would involve significant challenges and be extremely expensive. A draw down of the lake may be necessary install the barrier, and if the lake level is not regulated by control structures, this can be almost impossible. For a large lake, material costs alone would be enormous.

Once in place, the barrier would prevent not only invasive plant growth, but native plant growth as well, destabilizing the lake ecosystem and having a negative impact on insect and fish communities. Sediment would gradually accumulate on top of the barrier, and aquatic plant growth would return as plants begin to take root in the sediment on top of the barrier. An IDNR permit is required for the placement of a bottom barrier.

9.6 Biological Controls

9.6.1 Water Milfoil Weevil



The water milfoil weevil is a native North American insect that consumes Eurasian milfoil and northern milfoil. The weevil was discovered after a decline in the Eurasian milfoil population was observed in Brownington Pond, Vermont (Creed and Sheldon, 1993). The milfoil weevil burrows down into the stem of the plant and consumes the tissue of the plant. Holes in the milfoil stem bored by weevil larvae allow disease to enter the plant. These same holes also cause a release of the plants' gases which reduces buoyancy and causes the plant to sink (Creed et. Al. 1992).

Studies conducted to evaluate the effectiveness of the water milfoil weevil have not yielded consistent results. Factors influencing the weevil's success or failure in a body of water are not well documented. In 2003, Scribailo and Alix conducted a weevil test on Round Lake in Indiana and found no conclusive evidence that the Eurasian milfoil populations were reduced. An IDNR permit is required to stock weevils.

9.6.2 Grass Carp

www.tpwd.state.tx.us

The Asian grass carp or white amur (*Ctenopharyngodon idella*) is an herbivorous fish that is native to eastern Russia and China. This fish has been introduced into the U.S. to help control aquatic vegetation. To prevent their uncontrolled proliferation, all fish stocked in Indiana must be triploid, meaning that they cannot reproduce. Stocking is restricted to privately owned bodies of water, and suppliers must obtain a special permit from the IDNR. Grass carp are completely vegetarian, feeding on many species of submersed plants, along with some floating plants such as duckweed. Hydrilla, a highly invasive plant found in many southern states is a preferred food of grass carp and efforts to control hydrilla with grass carp have been successful.

According to the Aquatic Ecosystem Restoration Foundation, grass carp avoid Eurasian milfoil, and show strong preferences for many native plants along with hydrilla. The success of grass carp stockings is highly dependent upon the food sources available to the fish. When Eurasian milfoil occurs along with native plant populations, grass carp are not recommended.

9.7 Chemical Controls

9.7.1 Aquatic Herbicides

There are two major categories of aquatic herbicides: contact and systemic herbicides. Contact herbicides are used best to control the majority of the weeds close to shore, around piers and in man-made channels. Examples of contact herbicides are Reward (active ingredient: diquat), and Aquathal (active ingredient: endothal).
Contact herbicides would not be a wise choice for a whole lake treatment because of their lack of selectivity and their inability to eliminate the root systems of treated plants. These characteristics could result in unnecessary damage to native species, as well as greater potential for the re-infestation of Eurasian milfoil.

Systemic herbicides are absorbed by the plant and transported to the root systems where they eliminate both the roots and the plant. Examples of systemic herbicides are Sonar and Avast (active ingredient: fluridone), Navigate, Aqua Kleen, DMA4 (active ingredient 2, 4-D) and Renovate (active ingredient: triclopyr). All of these chemicals effectively kill Eurasian milfoil plants and roots. Based on the author's experience and other lake managers in the Midwest, whole lake treatments using fluridone are the most effective way to control Eurasian water milfoil in lakes that have become severely infested. Fluridone can be applied at low rates to control the Eurasian milfoil while causing little or no harm to the majority of the native weed species present in the lake.

2, 4-D and triclopyr are both root control herbicides which can to be used for spot treatments in small areas of Eurasian milfoil infestation, while the whole lake must be treated if fluridone is used. The major difference between 2, 4-D and triclopyr is that triclopyr is

showing that it may have the ability to control the Eurasian milfoil in select areas longer than 2,4-D. Renovate (triclopyr) has only been available for use for the past three seasons, and the ability of Renovate to provide more long term control of Eurasian milfoil than 2,4-D in spot treatment situations is still being documented. 2, 4-D is less expensive to use but if triclopyr continues to show better long term control in treated areas it will may become the most cost effective long term investment.

The public's primary concern with the use of aquatic herbicides is safety. Every chemical registered for aquatic applications has undergone extensive testing prior to becoming available for use. These tests demonstrate that when these herbicides are applied properly at labeled rates, they are safe for humans and will not cause any adverse environmental effects.

10.0 Public Involvement

The public meeting was held on November 11, 2006. Twenty people were in attendance. Main concerns were poor water quality and excessive plant growth, especially from Eurasian watermilfoil. When treatment options were discussed one major concern was the potential for coontail proliferation when the Eurasian watermilfoil population was reduced.

Another concern was that algal blooms could significantly increase if a large amount of vegetation was removed from the lake. Heavy algal blooms are a yearly occurrence on Shipshewana Lake, due to its high fertility. Members of the public expressed a desire to pursue a LARE funded treatment at Shipshewana to alleviate some of the problems caused by excessive vegetation growth. They also expressed confidence that the association could raise funding needed to cover its share of the costs for this project.

Table 14 is a summary of the public questionnaire data received from input at public meetings. Questionnaires were handed out to all in attendance at the public meeting. Data was compiled and the original questionnaire was used to show a summary of all responses.

Table 14: Shipshewana Lake Public Questionnaire

Total: 20

Lake Use Survey

Lake name Shipshewana

Are you a lake property owner? Yes 20 No 0

Are you currently a member of your lake association? Yes 15 No 5

How many years have you been at the lake?
2 or less - 2
2 – 5 years - 5
5-10 years - 3
Over 10 years - 10

How do you use the lake (mark all that apply)
10 Swimming
16 Boating
16 Fishing
___ Irrigation
___ Drinking water
2 Other _____

Do you have aquatic plants at your shoreline in nuisance quantities? Yes 12 No 6

Do you currently participate in a weed control project on the lake? Yes 3 No 11

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes 16 No 3

Does the level of vegetation in the lake affect your property values? Yes 18 No 1

Are you in favor of continuing efforts to control vegetation on the lake? Yes 19 No 0

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded? Yes 14 No 5

Mark any of these you think are problems on your lake:
___ Too many boats access the lake
___ Use of jet skis on the lake
___ Too much fishing
___ Fish population problem
6 Dredging needed
___ Overuse by nonresidents
18 Too many aquatic plants
___ Not enough aquatic plants
16 Poor water quality
___ Pier/funneling problem

Please add any comments:
Drainage of ditch from farm on CR 1000 into lake; green algae; need public sewer soon!; recreation enhancement needed to enhance ministry to campus and guests on south side of the lake

11.0 Public Education

Lake residents play an important role in establishing and maintaining a healthy lake community. Lake association meetings and newsletters are excellent avenues through which this information about management practices on Shipshewana Lake can be distributed. These meetings can also help to inform the public about practical steps that they can take to improve Shipshewana Lake. The following information is designed to give practical suggestions on ways that lake residents can reduce nutrient loading and improve the Shipshewana Lake ecosystem.

1. **Ensure that existing homes be connected to a properly maintained lake wide sewer system if possible.** Many older homes possess septic systems without proper filter beds. Some systems may have significant leaks, while some may drain into the lake. Sewage leaks add tremendous amounts of nutrients to the water, along with harmful bacteria.

2. **Limit lawn fertilizer use in areas where runoff will enter the lake.** If a fertilizer application must be applied, avoid spreading fertilizer directly into the lake, on sidewalks, or sea walls where it will wash into the lake. Try to avoid applying fertilizer within 30 feet of the lakeshore.

3. **Work with farmers within the lake catchment to increase proper filtration and drainage of agricultural land before runoff reaches the lake.** The Indiana state government offers incentives for farmers to address soil and water concerns through the U.S. Department of Agriculture. The Indiana Conservation Reserve Program (CRP) provides technical and financial aid to reduce soil erosion, reduce sediment in lakes and streams, and improve overall water quality. Farmers owning highly erodable land or property adjacent to tributary streams or lakes may be eligible for funding that can increase water quality significantly. Further information can be found at www.in.nrcs.usda.gov/programs/CRP/crphomepage.html or by contacting the following address.

   Indiana NRCS
   6013 Lakeside Boulevard
   Indianapolis, Indiana 46278-2933
   Phone: (317) 290-3200
   FAX: (317) 290-3225

4. **Avoid blowing grass clippings and tree leaves into the lake**. Many pond owners know that grass clippings blown into a pond can turn into a floating mat of algae in only a few days. This occurs because cut and decaying vegetation rapidly releases nutrients into the water.

5. **Prevent or reduce urban and industrial runoff flowing directly into the lake.** Urban runoff can be one of the most detrimental factors influencing water quality. Not only are nutrients and sediment carried to lakes through storm sewers, but harmful contaminants as well. Oil, antifreeze, gasoline, road salt, and other

pollutants are washed from pavement and can all end up harming a lake ecosystem.

The following are practical steps recommended by the United States Environmental Protection Agency to reduce urban runoff:

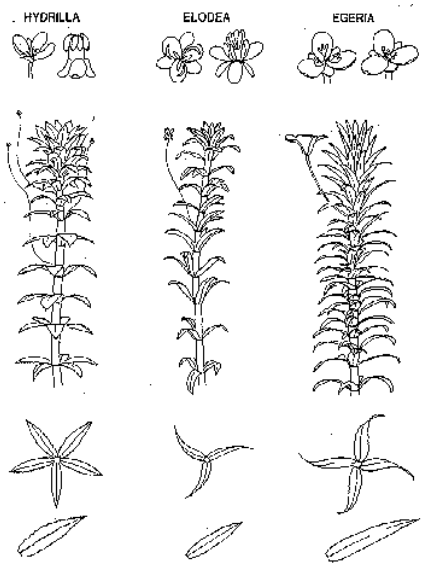
a) Protect areas that provide important water quality benefits or are particularly susceptible to erosion or sediment loss.
b) Limit land disturbance such as clearing and grading and cut fill to reduce erosion and sediment loss.
c) Limit disturbance of natural drainage features and vegetation.
d) Place bridge structures so that sensitive and valuable aquatic ecosystems are protected.
e) Prepare and implement an approved erosion control plan.
f) Ensure proper storage and disposal of toxic material.
g) Incorporate pollution prevention into operation and maintenance procedures to reduce pollutant loadings to surface runoff.
h) Develop and implement runoff pollution controls for existing road systems to reduce pollutant concentrations and volumes.

Further information about urban runoff in Indiana can be obtained by contacting the EPA Region 5 National Pollution Discharge Elimination System Storm Water Coordinator by calling (312) 886-6100.

6. **Establish ecological zones to protect existing wetlands and emergent vegetation from turbulence caused by boats.** Wetlands not only filter water, but they also stabilize shoreline areas that would otherwise be highly erodable. Submersed and emergent vegetation can be eliminated by heavy wave action, which destabilizes the shoreline and reduces the lake's natural defense against sediment and nutrient loading. It is extremely important to make sure that existing wetlands remain intact to aid in the natural water purification process. If possible lake associations should identify significant wetland areas and work with the IDNR to protect them from drainage and disruption.

Hydrilla

Hydrilla (*Hydrilla verticillata*) is an invasive aquatic plant species common throughout the southern United States. It it federally listed as a noxious weed and causes severe ecological and recreational problems wherever it grows. It is considered to be much more destructive than other invasives like Eurasian watermilfoil and curly leaf pondweed because of its reproductive adaptations. It grows by fragmentation, as does Eurasian watermilfoil, but it also produces turions which can remain dormant in the sediment for 4 years or more (Van and Steward, 1990). It produces tubers at its root tips which can also reproduce after multiple years of dormancy. It can grow 1 inch each day and it quickly out-competes native plants. It forms dense beds that eliminate native plants, stunt fish populations, impede recreation and cause a drastic decrease in biodiversity (Colle and Shireman, 1980). Millions of dollars are spent each year for hydrilla maintenance each year in Florida alone. Eradication is unlikely once a population has been well established, although eradication has been achieved in newly infested waters using a herbicide called Sonar. Sonar is applied at a rate of 6 parts per billion and this concentration is maintained in the water for 180 days. Early detection can be crucial to an effective eradication program, and all lake residents and users are encouraged to be on the look-out for this invader.



In fall of 2006, this plant was found in Lake Manitou, in Rochester, Indiana. This is the first instance of hydrilla in the upper Midwest. Prior to its appearance in Lake Manitou, The closest infestations of hydrilla were in Tennessee and Pennsylvania.

Hydrilla can easily be confused with native elodea. The major difference is that elodea has sets of leaves on the stem in whorls of three, while hydrilla usually has whorls of 5 leaves, although 4 to 9 leaves per whorl are possible with hydrilla. Hydrilla will also have small serrations on the leaf edges. More information on hydrilla can be found at the University of Florida's Center for Aquatic Invasive Plants (http://plants.ifas.ufl.edu/). More general information on aquatic invaders can be found at www.protectyourwaters.net.

12.0 Integrated Treatment Action Strategy

Treating Eurasian watermilfoil with Sonar herbicide (active ingredient: fluridone) will provide the best control and be the most cost effective treatment over a 3 year period. Although Sonar is an expensive chemical, application rates are based largely on acreage and average depth. Since Shipshewana Lake has an average depth of only 7 feet, this greatly reduces the amount of fluridone that is required. Other chemicals such as 2, 4-D, Renovate, and Reward are better suited for spot treatments. Since Eurasian watermilfoil is so widely distributed, spot treatments covering over 50 acres would be less effective than a whole lake treatment. Treating these areas with 2, 4-D would cost approximately $19,875 per year. Treating these areas with Renovate would cost $24,645 per year. These treatments would have to be conducted each year. The whole lake can be treated once with Sonar for approximately $26,300 with estimated maintenance costs of under $2,000 per year in the two years following treatment. Table 15 outlines treatment options and cost estimates.

Table 15: Treatment Options and Costs

Shipshewana Lake Treatment Options

	2007	2008	2009	Total – 3years
6ppb Fluridone, Whole Lake				
Total Estimated Cost	26,300			
LARE Share – subject to availability	23,670			
Association's Share	2,630.00			
Follow Up Spot Treatments 2,4-D, (5? Acres)				
Total Estimated Cost		1,875	1,875	30,050
LARE Share – subject to availability		1,687.50	1,687.50	27,045
Association's Share		187.50	187.50	3,005.00
Additional 2ppb to Control Coontail				
Total Estimated (additional cost)	3,200			
LARE Share – subject to availability	N/A			
Association's Share	N/A			
2,4-D Treatment, 53 Acres				
Total Estimated Cost	19875	19875	19875	59,625
LARE Share – subject to availability	17,887.50	17,887.50	17,887.50	53,662.50
Association's Share	1,987.50	1,987.50	1,987.50	5,962.50
Renovate Treatment, 53 Acres				
Total Estimated Cost	24,645	24,645	24,645	73,935
LARE Share – subject to availability	22,181.50	22,181.50	22,181.50	66,544.50
Association's Share	2,464.50	2,464.50	2,464.50	7,396.50

It is recommended that Shipshewana Lake be treated with fluridone to control the Eurasian milfoil and to kill its roots as well. This treatment will greatly reduce the potential for rapid re-growth of Eurasian milfoil plants. The following table summarizes treatment options.

This plan has been discussed with Neil Ledet and Larry Koza (IDNR biologists for Shipshewana Lake) and a treatment permit would be issued for this treatment. Fluridone would be applied in late April or May and would take between 90 and 120 days to achieve control of Eurasian milfoil.

The herbicide applicators will use a “6 bump 6” program to achieve maximum controlof Eurasian watermilfoil in Shipshewana Lake (Additional Sonar will be added for some control of Coontail). This means the entire lake would be treated with 6 ppb (parts per billion) of fluridone. This is the lowest rate of fluridone that will achieve control of Eurasian watermilfoil and is the only fluridone concentration for Eurasian watermilfoil currently accepted by the IDNR. After the initial treatment, applicators will allow three weeks for the fluridone to be absorbed by the Eurasian milfoil. At the conclusion of 3 weeks from the initial treatment date, a FasTEST will be conducted, meaning that water samples will be taken to determine the concentration of fluridone still present in Shipshewana Lake. These water samples will be sent to SePro (Manufacturer of Sonar). After performing the FasTEST and determining this concentration, a second application of fluridone will take place to increase the Sonar concentration back to 6ppb in Shipshewana Lake.

It is recommended that extra fluridone be added to the treatment to bring its concentration in Shipshewana Lake to 8 ppb during the chemical treatment. This should provide some control for Coontail and prevent its proliferation as the Eurasian watermilfoil population is reduced.

These low chemical rates would have no direct adverse effects on the fish and only small short term effects on many native plant species. Stress imposed upon fish would be greatly reduced when compared to most chemical treatments since Eurasian milfoil would die out slowly over the course of 90 to 120 days. This extended die off period protects against dramatic fluctuations of dissolved oxygen which could be harmful to fish.

It is important to outline the risks of this management plan on Shipshewana Lake. Reducing the Eurasian watermilfoil and coontail populations will free up nutrients in the lake, which will likely result in a heavy planktonic algae bloom. This will make the water extremely green and may prevent other native plants from growing. Extremely heavy algal blooms could possibly cause a severe fish kill, although it is not expected. Because of poor plant diversity in Shipshewana Lake, it is not expected that beneficial native plants will quickly fill the void left by Eurasian watermilfoil. Also, it is not known how long coontail will remain at acceptable levels after 2007. Even with these risks, this management plan should provide the best opportunity to improve what is now a very difficult plant situation at Shipshewana Lake.

13.0 Project Budget

The following cost figures are estimates only. They are based on lake size, average depth, chemical costs, and application costs. Prices are subject to change pending chemical pricing in future years.

Table 16: Shipshewana Lake Cost Estimates

Project	2007	2008	2009	3 Year Cost Totals
Whole Lake Fluridone Treatment - 6ppb				
Total Estimated Costs	$ 26,300	$0	$0	**$ 33,250**
LARE share – subject to availability	$ 23,670			**$ 27,045**
Association's Share	$ 2,630			**$ 6,205**
Additional 2 ppb to Control Coontail Additional Cost to Association (Not Eligible for LARE Funding)	$3,200			
Follow Up Spot Treatments using 2, 4-D				
Total Estimated Costs	$0	$ 1,875	$ 1,875	
LARE Share – subject to availability		$1687.50	$1687.50	
Association's Share		$187.50	$187.50	

Survey and planning costs

The association should budget $4000.00 (90/10 match) but this cost may be less should LARE reduce the survey intensity and planning required.

14.0 Monitoring and Plan Update Procedures

In 2007 a visual inspection should be sufficient to confirm the presence of Eurasian watermilfoil prior to treatment in spring of 2006. It is recommended that a late season Tier II survey be conducted on Shipshewana Lake in 2006 to monitor changes in the plant community as a result of the herbicide treatment. This survey should be conducted in late summer or early fall to allow the slow acting herbicide to achieve full control before the survey is conducted.

In the years that follow, additional surveys should be conducted to determine how the Eurasian milfoil population is reacting to the management strategy over a long period of time. These surveys will provide a basis for evaluation of the management strategy and can be presented to the public should the need arise to modify the management strategy. They will also serve to keep the public interested and informed about management practices at the lake so they will be motivated and equipped to actively participate in the conservation of the Shipshewana Lake ecosystem. The intensity and frequency of vegetation surveys may change from year to year. Survey and planning needs should be re-evaluated each year to reduce unnecessary cost to the lake association while still providing adequate data to characterize the plant community.

15.0 References

Blessing, Arlene. 2004. Fundamentals of Pesticide Use: Indiana Pesticide Applicator Core Training Manual. Purdue University. West Lafayette, Indiana 106 pp.

Colle DE, Shireman JV. 1980. Coefficients of condition for largemouth bass, bluegill and redear sunfish in hydrilla-infested lakes. Transactions of the American Fisheries Society 109:521-531.

Cunningham, Willam P., and Saigo, Barwbara W. 2001. Environmental Science: a Global Concern. McGraw Hill Inc. Boston, Massachusetts 646.

Getsinger, Kurt Ph.D. 2005. Aquatic Plant Management: Best Management Practices in Support of Fish and Wildlife Habitat. The Aquatic Ecosystem Restoration Foundation. 78 pp.

IDNR. 2004. Procedure Manual for Surveying Aquatic Vegetation: Tier I Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

IDNR. 2004. Procedure Manual for Surveying Aquatic Vegetation: Tier II Reconnaissance Surveys. IN Department of Natural Resources, Division of Soil Conservation.

Kalff, Jacob. 2002. Limnology: Inland Water Ecosystems. Prentice Hall. Upper Saddle River, New Jersey. 592 pp.

Kannenburg, James R., and Schmidt, James C. 1998. How to Identify and Control Water Weeds and Algae: 5th edition. Applied Biochemists. Milwaukee, Wisconsin. 128pp.

Koza, Larry. 2002. Shipshewana Lake: Lagrange County Fish Management Report. Indiana Department of Natural Resources Division of Fish and Wildlife.

Lembi, Carole 1997. Aquatic Pest Control: Category 5. Department of Botany and Plant Pathology: Purdue University. West Lafayette, Indiana. 58pp.

Pearson, Jed. 2004. A Proposed Sampling Method to Assess Occurrence, Abundance and Distribution of Submersed Aquatic Plants in Indiana Lakes. IN Department of Natural Resources. Division of Fish & Wildlife.

Pullman, Douglas G. 1998. The Lake Association Leaders Aquatic Vegetation Management Guidance Manual.

Scribalio, Robin W. Ph.D. & Alix, Mitchell S. 2003. Final Report on the Weevil Release Study for Indiana Lakes. Department of Botany and Plant Pathology. Purdue University. West Lafayette, IN.

Smith, Robert Leo and Smith, Thomas M. 2001. Ecology and Field Biology. Addison Wesley Longman, Inc. San Francisco, California. 771 pp.

Stern, Kinsingly R. 2000. Introductory Plant Biology. McGraw Hill. Madison, Wisconsin. 557 pp.

Tyllia, J. 2000. Northeastern Indiana Fishing Map Guide. Superior, Wisconsin. 184 pp.

Van TK, Steward KK. 1990. Longevity of monoecious hydrilla propagules. J. Aquat. Plant Manage. 28:74-76

16.0 Appendices

16.1 Calculations

Fluridone Calculations:

The following paragraph is taken directly from the Sonar A.S. label. It outlines the specific procedures for calculating the amount of Fluridone needed to treat a body of water.

Application Rate Calculation - Ponds, Lakes and Reservoirs

The amount of Sonar A.S. to be applied to provide the desired ppb concentration of active ingredient in treated water may be calculated as follows:
Quarts of Sonar A.S. required per treated surface acre = Average water depth of treatment site (feet)
x Desired ppb concentration of active ingredient
x 0.0027
For example, the quarts per acre of Sonar A.S. required to provide a concentration of 25 ppb of active ingredient in water with an average depth of 5 feet is calculated as follows:
5 **x** 25 **x** 0.0027 = 0.33 quarts per treated surface acre
When measuring quantities of Sonar A.S., quarts may be converted to fluid ounces by multiplying quarts to be measured **x** 32. For example, 0.33 quarts **x** 32 = 10.5 fluid ounces.
Note: Calculated rates should not exceed the maximum allowable rate in quarts per treated surface acre for the water depth listed in the application rate table for the site to be treated.

16.2 Common Aquatic Plants of Indiana

The following appendix was compiled using information found in the 5th edition of How to Identify Water Weeds and Algae, edited by James C. Schmidt and James R. Kannenberg. All pictures, with the exception of Illinois pondweed and northern milfoil were taken from the Category 5 Aquatic Pest Control Management Manual, written by Dr. Carole Lembi, Head of the Department of Botany and Plant Pathology at Purdue University.

American Pondweed

Scientific name: *Potamogeton americanus*

Classification: Native to Indiana

Distribution: Common throughout the U.S.

Description: American pondweed can be identified by its oval shaped leaves floating on the top of the water. The base of each leaf tapers to a very long petiole that connects the leaf with the stem of the plant. Plant leaves are arranged alternately on the stem and leaves are usually sparsely scattered.

Chara

Scientific name: *Chara sp*.

Classification: Native to Indiana

Distribution: Extremely common worldwide. Usually found in hard water.

Description: Chara is often mistaken for a vascular plant, but it is actually an advanced form of algae. It can be gray, green or yellow in color and is usually forms extremely dense beds that may cover an entire lake. It can be identified by its distinct musky odor and calcium deposits on the algae's surface make it feel bristly to the touch. It possesses leaf-like structures that are whorled around the hollow stem, and it attaches itself to the lake bottom, although it has no actual roots. It usually grows in shallow, clear water.

Coontail

Scientific name: *Ceratophyllum demersum*

Classification: Native to Indiana

Distribution: Common throughout the U.S., usually in hard water.

Description: Coontail plants are submersed and have no roots, though they appear to be attached to the lake bottom when viewed from above the surface of the water. The free-floating nature of coontail allows it to colonize new areas of a lake quickly, and it often times forms extremely dense weed beds where sufficient light and nutrients are available. Coontail has dark green leaves arranged in whorls around the stem and usually grows in long, bushy strands resembling evergreen trees beneath the surface of the water. Coontail's structure is very similar to Eurasian milfoil but coontail has forked leaves, which distinguishes it from the feather-like projections of milfoil leaves.

Curley Leaf Pondweed

Scientific name: *Potamogeton crispus*

Classification: Exotic to Indiana

Distribution: Found throughout the U.S. in fresh and brackish water.

Description: Curley leaf pondweed usually grows and spreads rapidly in early spring and begins to dies out by midsummer as water temperatures approach 70 degrees Fahrenheit. Curley leaf has extremely thin, membranous leaves arranged alternately on the stem with small teeth-like projections visible along the edge of each leaf. A reproductive spike may be seen protruding from the surface of the water. Curley leaf pondweed may also leave small reproductive structures called turions in the sediment on the lake bottom that can lie dormant throughout the winter and then sprout when spring arrives.

Eel Grass (Wild Celery)

Scientific name: *Vallisneria Americana*

Classification: Native to Indiana

Distribution: Found from the Great Plains to the East Coast of the U.S.

Description: Eel grass has tufts of ribbon-like leaves with a horizontal stem embedded in the sediment connecting each tuft. This native plant grows thick weed beds anchored in the mud by roots. These dense beds often shade out other forms of weeds and provide excellent escape cover for small fish. The flowers of this plant are visible in late summer and sit on the top of a coiled structure protruding to the surface. This plant is found in both lakes and river, but is seldom found in stagnant systems. It is considered an extremely valuable plant to aquatic ecosystems.

Elodea

Scientific Name: *Elodea Canadensis*

Classification: Native to Indiana

Distribution: Common throughout the north and north central united states. Its ranges extends as far south as northern Tennnessee.

Description: Elodea grows in long strands resembling milfoil, but its leaves are broad and oval shaped. Leaves are arranged in whorls with three leaves usually occurring at each node. Leaves near the tip of the plant are closely packed together, with the distance between nodes increasing further down the stem.

Eurasian Milfoil

Scientific Name: *Microphyllum spicatum*

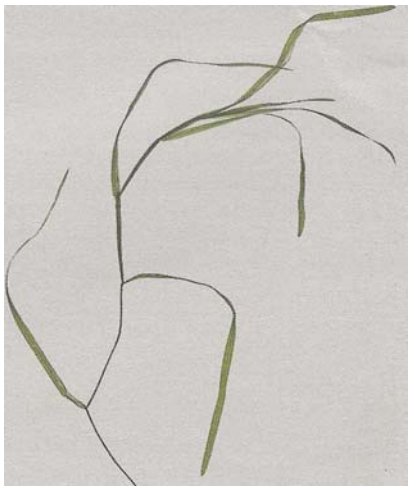
Classification: Exotic in Indiana

Distribution: Common in the Midwest and Eastern U.S. Also spreading along the Pacific coast

Description: This extremely aggressive and extremely destructive plant has leaves in whorls of 4 around a reddish stalk. This plant grows rapidly and can reach lengths of over 10 feet. This plant has the ability to over winter, meaning it can lie dormant during the winter months instead of dying out completely each year. This gives it a distinct advantage over many native species, as it competes for sunlight in early spring. The dormant milfoil plants reach the surface much faster than the native plants sprouting from the lake bottom. This enables the Eurasian milfoil to shade out other plants and form the dense beds that choke the littoral zone of many lakes.

A reproductive process called fragmentation aids the rapid dispersion of Eurasian milfoil. If a milfoil plant is damaged and some fragments are removed from the macrophyte, each small piece of the plant has the ability to grow roots and create a new milfoil plant. Eurasian milfoil is considered one of the most dangerous aquatic nuisance species because of its ability to rapidly disrupt and destroy lake ecosystems.

Flat-stemmed Pondweed



Scientific Name: *Potamogeton zosteriformis*

Classification: Native to Indiana

Distribution: Common throughout the northern half of the U.S.

Description: the most noticeable characteristic is the large, very flat stem. It cannot be rolled between the fingers easily. The ribbon-like leaves extend from the stem toward the surface of the water.

Illinois Pondweed

Scientific name: *Potamogeton illinoensis*

Classification: Native to Indiana

Distribution: Very widespread and very common throughout the upper Midwest and the U.S

Description: Illinois pondweed is common in Indiana, especially in the northern third of the state. This leafy weed has leaves with very broad bases that extend three-fourths of the way around the stem. The upper part of its slender stem is usually branched and very leafy.

www.wvu.edu

Large Leaf Pondweed

Scientific name: *Potamogeton amplifolius*
Classification: Native to Indiana
Distribution: Common throughout the upper Midwest and the northern United States in hard water.

Description: This plant has both submersed and floating leaves. The floating leaves are oval shaped and are similar to those of American pondweed. Submersed leaves are arranged alternately with each leaf becoming extremely narrow as it nears the stem of the plant. Mineral deposits on its leaves often give large leaf pondweed a dark brown appearance.

Naiad

Scientific name: *Najas minor* (brittle naiad)

Classification: Native to Indiana

Distribution: Common throughout the U.S.

Description: The leaves of naiad plants are usually widest at the base and gradually become thinner near the tip of the leaf. Plants are extremely leafy and appear bush-like when viewed from above the surface of the water. Many species of naiad are very common in this area. Plant structure often resembles chara, but the absence of calcium deposits on the surface of the plant help in identification. The leaves of brittle naiad have multiple spines along the margins that are visible to the naked eye.

Nitella

Scientific name: *Nitella sp.*

Classification: Native to Indiana

Distribution: Found worldwide, usually in hard water.

Description: Nitella is very similar to chara, and it is also an advanced form of algae. It has leaf-like projections that are whorled around the stem. It is often found growing in very thick patches, usually in shallow, clear water.

Northern Milfoil

www.io.uwinnipeg.ca

Scientific name: *Myriophyllum sibericum*

Classification: Native to Indiana

Distribution: Found throughout the northern half of the U.S. and also in Europe and Western Asia

Description: Northern milfoil has submersed, feather-like, whorled leaves that closely resemble the leaves of Eurasian milfoil. Distinguishing the native northern milfoil from Eurasian milfoil can be difficult. The leaflet pairs of northern milfoil are generally fewer and more widely spaced than those of Erasian milfoil. This plant is known to hybridize with Eurasian milfoil, and at times, chemical analysis is necessary to distinguish between the two plants.

Sago Pondweed

Scientific name: *Potemogeton pectinatus*

Classification: Native to Indiana

Distribution: Found throughout the U.S., Common in the northern 2/3 of Indiana.

Description: Sago Pondweed has a bushy appearance with narrow, thread-like leaves that spread out to resemble a fan. Leaves are usually 1/16 of an inch wide and 1 to 6 inches long. Nutlets are formed on a string-like structure and protrude from the surface of the water. While sago pondweed can form dense beds, many times it is found in sparse, loosely distributed arrangements.

16.3 Pesticide Use Restrictions Summary:

The following table was produced by Purdue University and included in the Professional Aquatic Applicators Training Manual. It gives a summary of water use restrictions on all major chemicals available for use in the aquatics market.

Table 17: Pesticide Use Restrictions

Table 1. Aquatic Herbicides and Their Use Restrictions. Always check the label because these restrictions are subject to change.

	Human			Animal	Irrigation		
	Drinking	Swimming	Fish Consumption	Drinking	Turf	Forage	Food Crops
	waiting period, in days						
Copper Chelate	0	0[a]	0	0	0	0	0
Copper Sulfate	0	0[a]	0	0	0	0	0
Diquat	1–3	0[a]	0	1	1–3	1–3	5
Endothall (granular)[b]	7	0[a]	3	0	7	7	7
Endothall (liquid)[b]	7–25	0[a]	3	7–25	7–25[d]	7–25	7–25
Endothall 191 (granular)[c]	7–25	0[a]	3	7–25	7–25	7–25	7–25
Endothall 191 (liquid)[c]	7–25	0[a]	3	7–25	7–25	7–25	7–25
Fluridone	0[e]	0[a]	0	0	7–30	7–30	7–30
Glyphosate	0[e]	0[a]	0	0	0	0	0
2,4-D (granular)	*	0[a]	0	*	*	*	*

[a]Although this compound has no waiting period for swimming, it is always advisable to wait 24 hours before permitting swimming in the direct area of treatment.

[b]Trade name is Aquathol®.

[c]Trade name is Hydrothol®.

[d]May be used for sprinkling bent grass immediately.

[e]Do not apply this product within 1/4 (fluridone) to 1/2 (glyphosate) mile upstream of potable water intakes.

*Do not use treated water for domestic purposes, livestock watering (2,4-D, dairy animals only), or irrigation.

16.4 Public Input Questionnaire Data

Table 18: Public Questionaire Sample

Total: 20

Lake Use Survey — Lake name Shipshewana

Are you a lake property owner? Yes 20 No 0

Are you currently a member of your lake association? Yes 15 No 5

How many years have you been at the lake?
- 2 or less - 2
- 2 – 5 years - 5
- 5-10 years - 3
- Over 10 years - 10

How do you use the lake (mark all that apply)
- 10 Swimming
- 16 Boating
- 16 Fishing
- ___ Irrigation
- ___ Drinking water
- 2 Other _____

Do you have aquatic plants at your shoreline in nuisance quantities? Yes 12 No 6

Do you currently participate in a weed control project on the lake? Yes 3 No 11

Does aquatic vegetation interfere with your use or enjoyment of the lake? Yes 16 No 3

Does the level of vegetation in the lake affect your property values? Yes 18 No 1

Are you in favor of continuing efforts to control vegetation on the lake? Yes 19 No 0

Are you aware that the LARE funds will only apply to work controlling invasive exotic species, and more work may need to be privately funded? Yes 14 No 5

Mark any of these you think are problems on your lake:
- ___ Too many boats access the lake
- ___ Use of jet skis on the lake
- ___ Too much fishing
- ___ Fish population problem
- 6 Dredging needed
- ___ Overuse by nonresidents
- 18 Too many aquatic plants
- ___ Not enough aquatic plants
- 16 Poor water quality
- ___ Pier/funneling problem

Please add any comments: Drainage of ditch from farm on CR 1000 into lake; green algae; need public sewer soon!; recreation enhancement needed to enhance ministry to campus and guests on south side of the lake

16.5 Resources for Aquatic Management

In addition to the LARE Program, there are many other sources of potential funding to help improve the quality of Indiana Lakes. Many government agencies assist in projects designed to improve environmental quality.

The USDA has many programs to assist environmental improvement. More information on the following programs can be found at www.usda.gov.

Watershed Protection and Flood Prevention Program (USDA

Conservation Reserve Program (USDA)

Wetlands Reserve Program (USDA)

Grassland Reserve Program (USDA)

Wildlife Habitat Incentive Program (USDA)

Small Watershed Rehabilitation Program (USDA)

The following programs are offered by the U.S. Fish and Wildlife Service. More information about the Fish and Wildlife service can be found at www.fws.gov

Partners for Fish and Wildlife Program (U.S. Fish and Wildlife Service)

Bring Back the Natives Program (U.S. Fish and Wildlife Service)

Native Plant Conservation Program (U.S. Fish and Wildlife Service)

The Environmental Protection Agency, the Indiana Department of Environmental Management, and the U.S. Forest Service also have numerous programs for funding. A few of these are listed below. More information can be found at www.in.gov/idem and www.fs.fed.us/

U.S. Environmental Protection Agency Environmental Education Program (EPA)

NPDES Related State Program Grants (IDEM)

Community Forestry Grant Program (U.S. Forest Service)

16.6 State Regulations for Aquatic Plant Management

The following information is found on the IDNR website and outlines general regulations for the management of aquatic plants in public waters.

AQUATIC PLANT CONTROL PERMIT REGULATIONS
Indiana Department of Natural Resources

Note: In addition to a permit from IDNR, public water supplies cannot be treated without prior written approval from the IDEM Drinking Water Section. **Amended state statute adds biological and mechanical control (use of weed harvesters) to the permit requirements, reduces the area allowed for treatment without a permit to 625 sq ft, and updates the reference to IDEM.** *These changes become effective on July 1, 2002.*

Chapter 9. Regulation of Fishing
IC 14-22-9-10

Sec. 10. (a) This section does not apply to the following:
(1) A privately owned lake, farm pond, or public or private drainage ditch.
(2) A landowner or tenant adjacent to public waters or boundary waters of the state, who chemically, mechanically, or physically controls aquatic vegetation in the immediate vicinity of a boat landing or bathing beach on or adjacent to the real property of the landowner or tenant if the following conditions exist:
(A) The area where vegetation is to be controlled does not exceed:
(i) twenty-five (25) feet along the legally established, average, or normal shoreline;
(ii) a water depth of six (6) feet; and
(iii) a total surface area of six hundred twenty-five (625) square feet.
(B) Control of vegetation does not occur in a public waterway of the state.
(b) A person may not chemically, mechanically, physically, or biologically control aquatic vegetation in the public waters or boundary waters of the state without a permit issued by the department. All procedures to control aquatic vegetation under this section shall be conducted in accordance with rules adopted by the department under IC 4-22-2.
(c) Upon receipt of an application for a permit to control aquatic vegetation and the payment of a fee of five dollars ($5), the department may issue a permit to the applicant. However, if the aquatic vegetation proposed to be controlled is present in a public water supply, the department may not, without prior written approval from the department of environmental management, approve a permit for control of the aquatic vegetation.
(d) This section does not do any of the following:
(1) Act as a bar to a suit or cause of action by a person or governmental agency.
(2) Relieve the permittee from liability, rules, restrictions, or permits that may be required of the permittee by any other governmental agency.
(3) Affect water pollution control laws (as defined in IC 13-11-2-261) and the rules adopted under water pollution control laws (as defined in IC 13-11-2-261).
As added by P.L.1-1995, SEC.15. Amended by P.L.1-1996, SEC.64.

312 IAC 9-10-3 Aquatic vegetation control permits
Authority: IC 14-22-2-6; IC 14-22-9-10
Affected: IC 14-22-9-10

Sec. 3. (a) Except as provided under IC 14-22-9-10(a), a person shall obtain a permit under this section before applying a substance to waters of this state to seek aquatic vegetation control.
(b) An application for an aquatic vegetation control permit shall be made on a departmental form and must include the following information:
(1) The common name of the plants to be controlled.
(2) The acreage to be treated.
(3) The maximum depth of the water where plants are to be treated.
(4) The name and amount of the chemical to be used.
(c) A permit issued under this section is limited to the terms of the application and to conditions imposed on the permit by the department.

(d) Five (5) days before the application of a substance permitted under this section, the permit holder must post clearly, visible signs at the treatment area indicating the substance that will be applied and what precautions should be taken.

(e) A permit issued under this section is void if the waters to be treated are supplied to the public by a private company or governmental agency. *(Natural Resources Commission; 312*

16.7 Species Distribution Maps

Figure 7: 2006 Coontail Sites

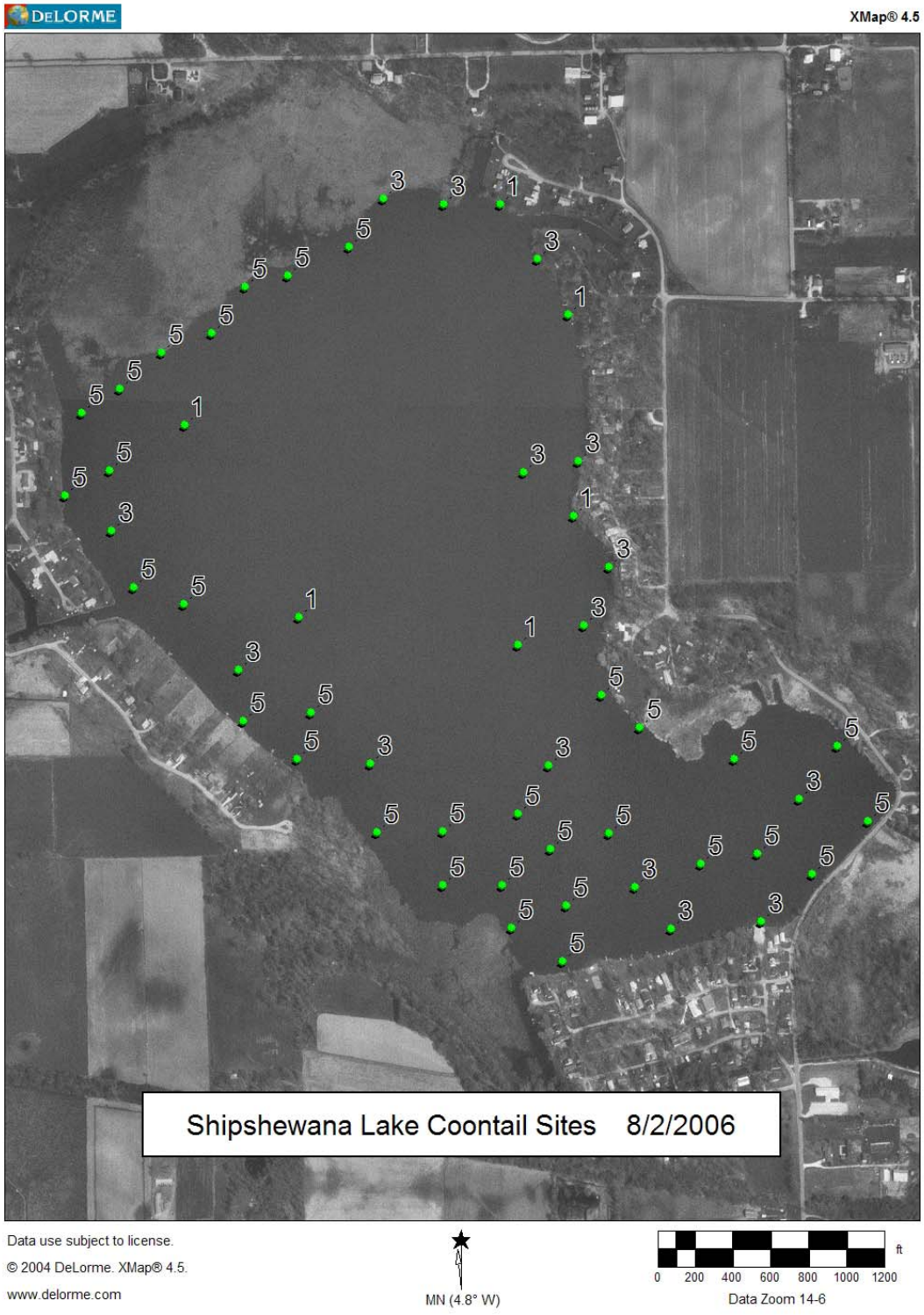


Figure 8: 2006 Eurasian Watermilfoil Sites

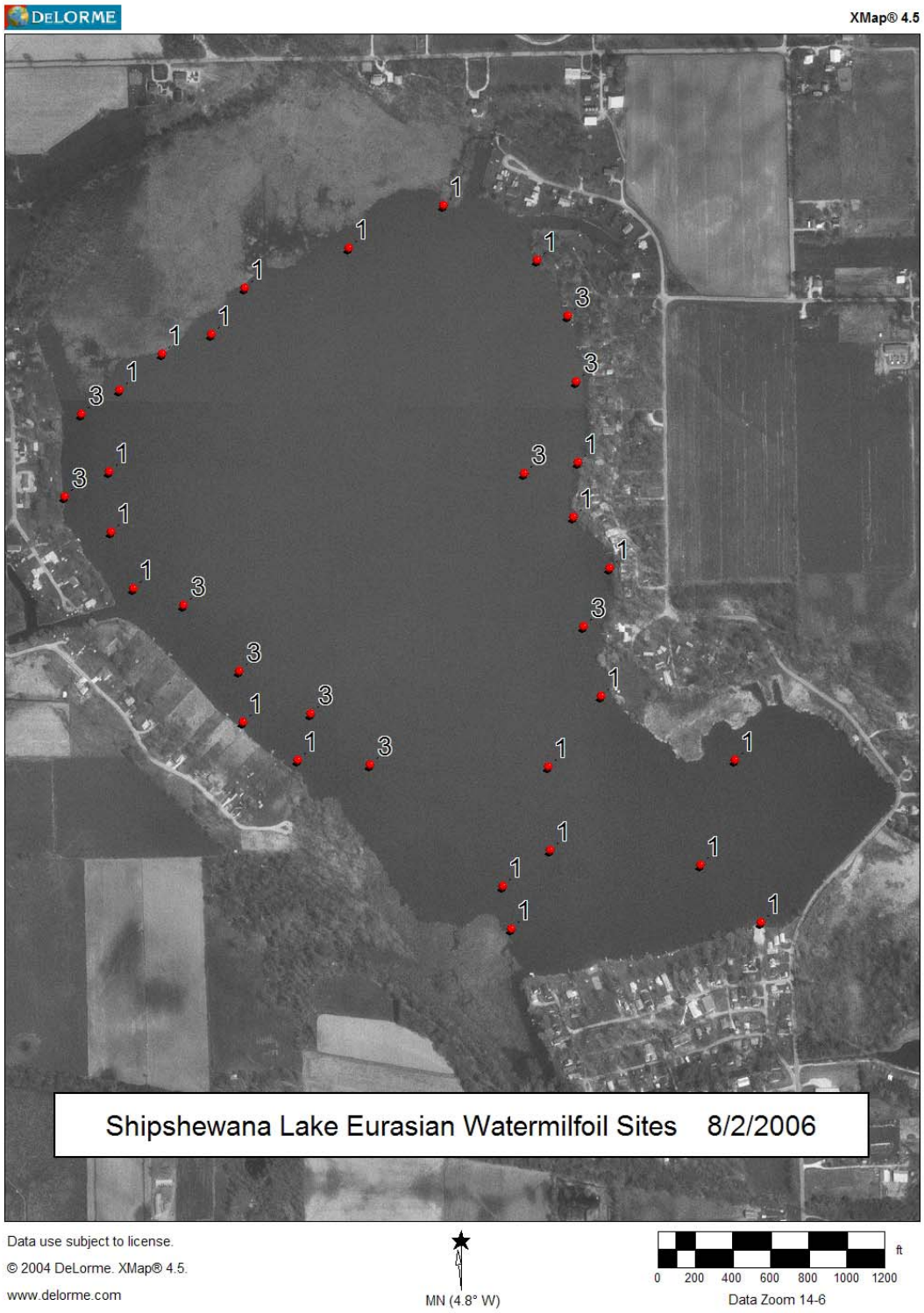


Figure 9: 2006 Leafy Pondweed Sites

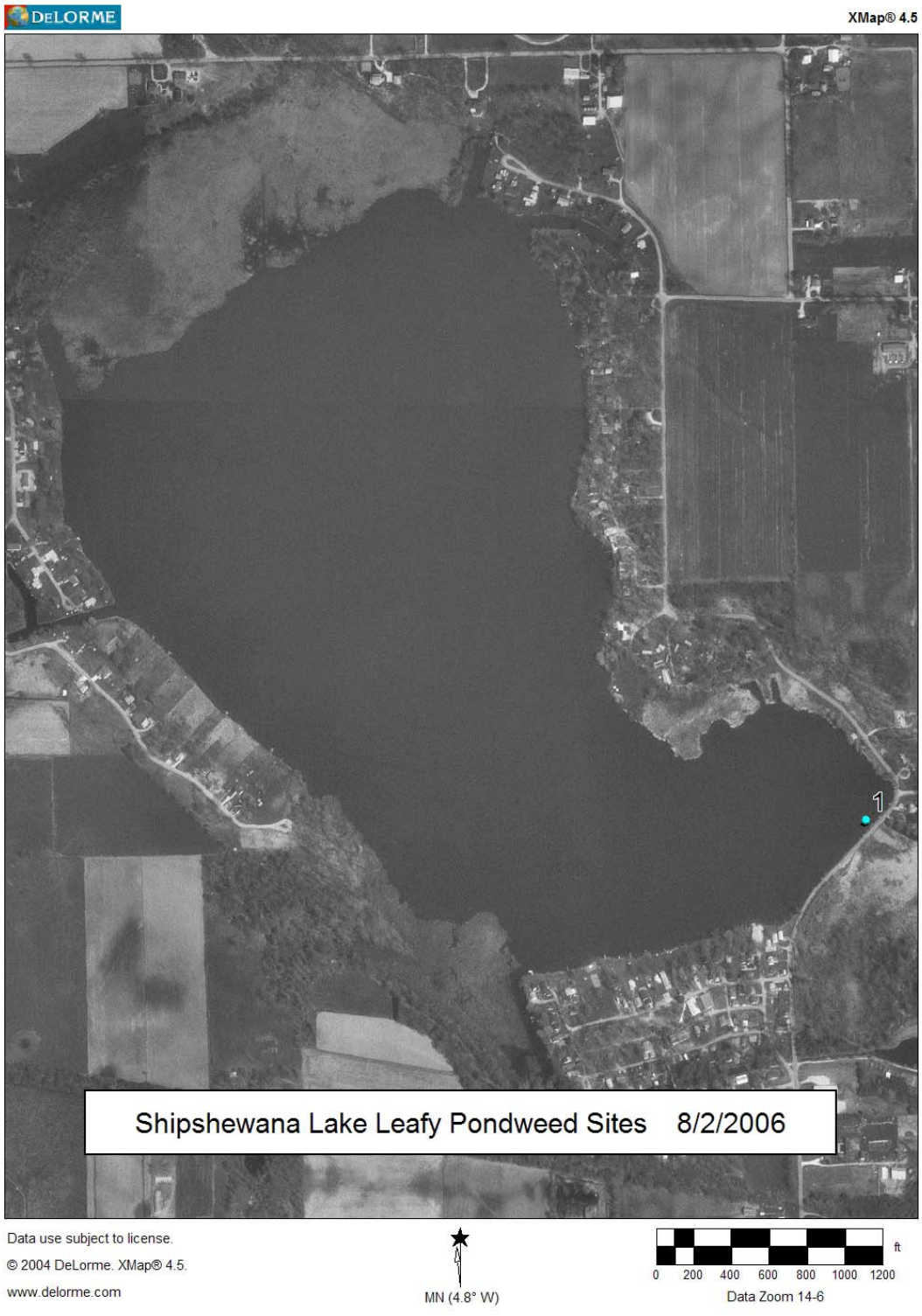
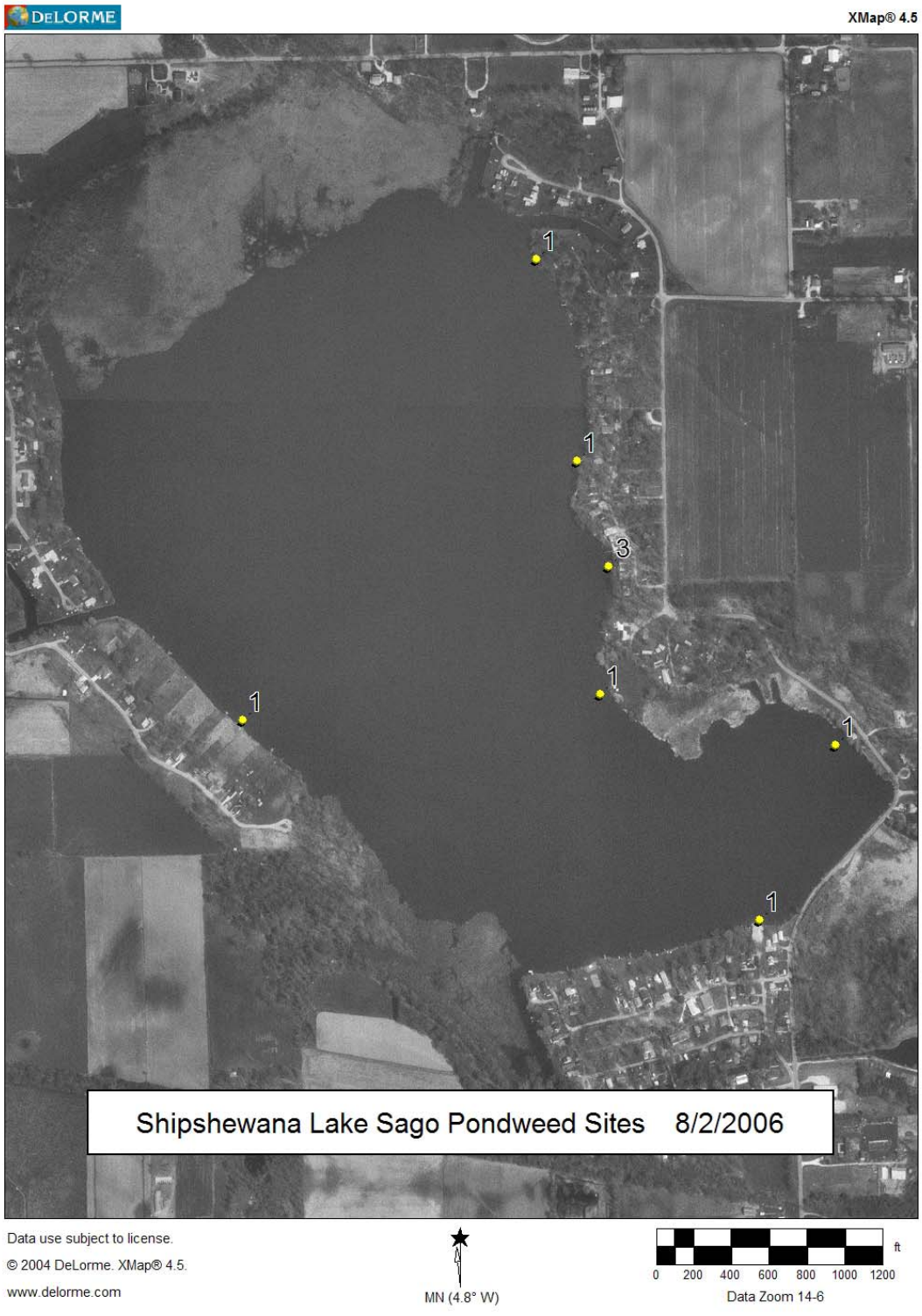
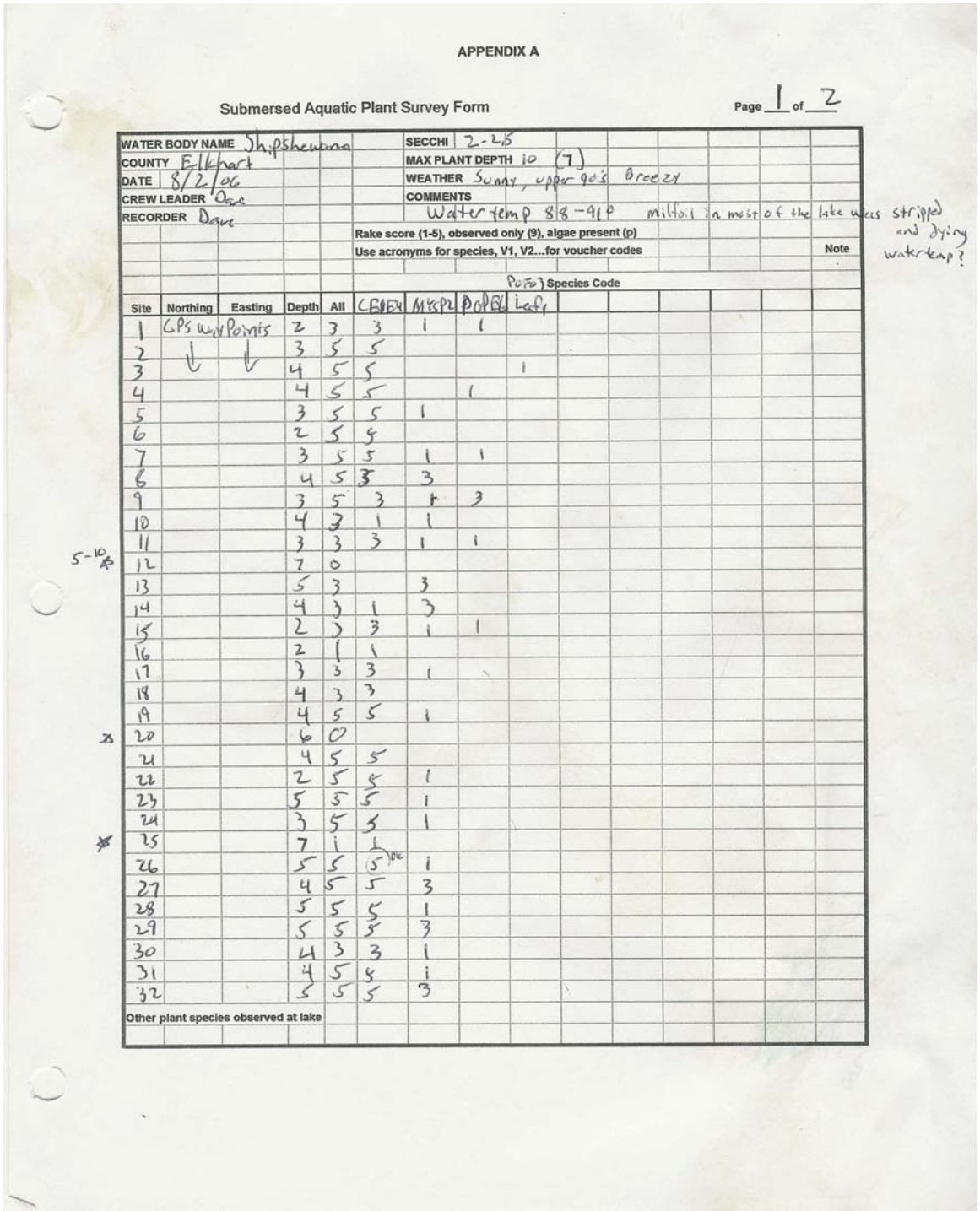


Figure 10: 2006 Sago Pondweed Sites



16.8 Data Sheets



APPENDIX A

Submersed Aquatic Plant Survey Form

Page 1 of 2

WATER BODY NAME Shipshewana
COUNTY Elkhart
DATE 8/2/06
CREW LEADER Dave
RECORDER Dave

SECCHI 2-2.5
MAX PLANT DEPTH 10 (7)
WEATHER Sunny, upper 90's Breezy
COMMENTS Water temp 88-91° milfoil in most of the lake was stripped and dying water temp?

Rake score (1-5), observed only (9), algae present (p)
Use acronyms for species, V1, V2...for voucher codes

Site	Northing	Easting	Depth	All	CHEX	MYSP	POFR	Leaf	Note
1	GPS w/ Points		2	3	3	1	1		
2	↓	↓	3	5	5				
3			4	5	5			1	
4			4	5	5		1		
5			3	5	5	1			
6			2	5	5				
7			3	5	5	1	1		
8			4	5	3	3			
9			3	5	3	1	3		
10			4	3	1	1			
11			3	3	3	1	1		
12			7	0					5-10 ft
13			5	3		3			
14			4	3	1	3			
15			2	3	3	1	1		
16			2	1	1				
17			3	3	3	1			
18			4	3	3				
19			4	5	5	1			
20			6	0					x3
21			4	5	5				
22			2	5	5	1			
23			5	5	5	1			
24			3	5	5	1			
25			7	1	1				x3
26			5	5	5	1			POC
27			4	5	5	3			
28			5	5	5	1			
29			5	5	5	3			
30			4	3	3	1			
31			4	5	5	1			
32			5	5	5	3			
Other plant species observed at lake									

Submersed Aquatic Plant Survey Form

Page 2 of 2[11]

WATER BODY NAME Shipshewana
COUNTY Elkhart
DATE 8/2/06
CREW LEADER Dave
RECORDER Dave
SECCHI ~2
MAX PLANT DEPTH 10(7)
WEATHER hot, sunny · upper 90's
COMMENTS

Rake score (1, 3, 5), observed only (9), algae present (p)
Use acronyms for species, V1, V2...for voucher codes

Note

Pofo3 Species Code

Site	Latitude	Longitude	Depth	All	CHDE4	MYSP2	POFO3	Leafy						
33	GPS	waypoints	7	1	1									
34	↓	↓	4	5	3	3								
35			4	5	5	1	1							
36			5	5	5	3								
37			4	5	5	1								
38			5	5	3	3								
39			8	0										
40			5	5	5									
41			5	5	5									
42			5	5	5									
43			5	5	5	1								
44			5	5	5									
45			6	3	3	1								
46			5	5	5	1								
47			3	5	5	1								
48			5	5	5									
49			3	5	5									
50			4	5	5									
51			5	3	3									
52			4	3	3									
53			4	5	5	1								
54			6	5	5									
55			5	3	3									
56			7	1	1									
57			8	0										
58			5	0										
59			9	0										
60			5	5	7	3								

Other plant species observed at lake

Aquatic Vegetation Plant Bed Data Sheet

Page 1 of 10

State of Indiana Department of Natural Resources

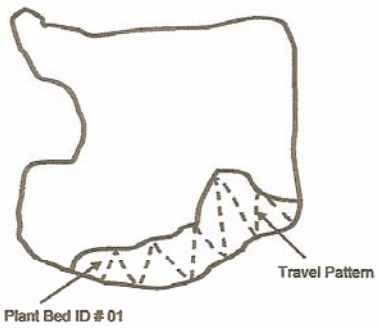
ORGANIZATION: Shipshewana Comm. Lake Improvement Assoc. DATE: 5/17/06

SITE INFORMATION					SITE COORDINATES
Plant Bed ID: S 1	Waterbody Name: Shipshewana				Center of the Bed
Bed Size: ~ 15ac					Latitude: N41 40.991
Substrate: 1	Waterbody ID:				Longitude: W85 36.056
Marl? 0	Total # of Species 3				Max. Lakeward Extent of Bed
High Organic? 1	CanopyAbundance at Site				Latitude: N41 40.985
	S: 4	N: -	F: -	E: -	Longitude: W85 36.133

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
POPEL	1			
CEDE4	3			
MYSP2	2			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Weed Control

Aquatic Vegetation Plant Bed Data Sheet

Page 2 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana Comm

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: S 2

Bed Size: N 2 acr

Substrate: 2

Marl? 0

High Organic? 1

Waterbody Name: Shipshewana

Waterbody ID:

Total # of Species 2

Canopy Abundance at Site

S: 4 N: F: E:

SITE COORDINATES

Center of the Bed

Latitude: N41 41.066

Longitude: W85 35.971

Max. Lakeward Extent of Bed

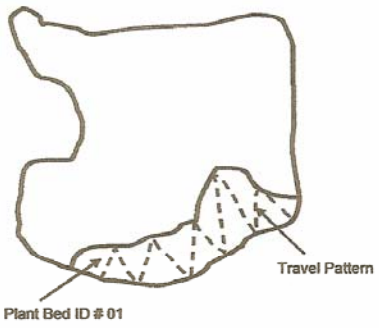
Latitude: N41 41.055

Longitude: W85 35.994

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP 2	3			
CEDE4	3			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 3 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: S 3

Bed Size: ~ 45 acre

Substrate: 1

Marl? 0

High Organic? 1

Waterbody Name: Shipshewana

Waterbody ID:

Total # of Species 3

Canopy Abundance at Site

S: 4 N: – F: – E: –

SITE COORDINATES

Center of the Bed

Latitude: N41.290

Longitude: W 85 36.284

Max. Lakeward Extent of Bed

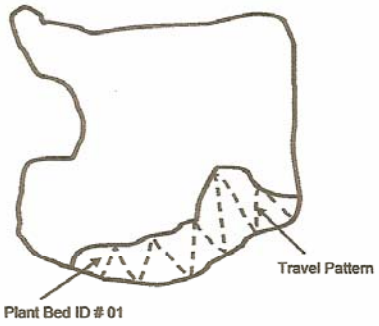
Latitude: N41 41.285

Longitude: W85 36.400

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3			
CEDE4	3			
POPE6	1			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Weed Control

Aquatic Vegetation Plant Bed Data Sheet

Page 4 of 10

State of Indiana Department of Natural Resources

ORGANIZATION:

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: 54

Bed Size: ~25 ac.

Substrate: 1

Marl? 0

High Organic? 1

Waterbody Name: Shipshewana

Waterbody ID:

Total # of Species 4

Canopy Abundance at Site

S: 4 N: F: E:

SITE COORDINATES

Center of the Bed

Latitude: N41 41.196

Longitude: W85 36.764

Max. Lakeward Extent of Bed

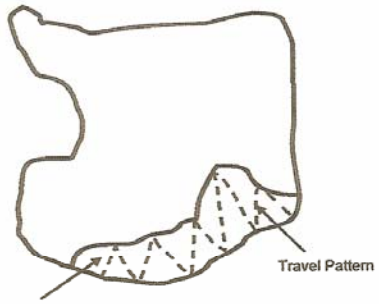
Latitude: N41 40 993

Longitude: W85 36.298

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
POCR3	2			
MYSP2	3			
CEDE4	2			
LEMN	1			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 5 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: 55

Bed Size: ~15 acres

Substrate: 1

Marl? 0

High Organic? 1

Waterbody Name: Shipshewana

Waterbody ID:

Total # of Species

CanopyAbundance at Site

S: 4 N: – F: – E: –

SITE COORDINATES

Center of the Bed

Latitude: N41 40.964

Longitude: W85 36.172

Max. Lakeward Extent of Bed

Latitude: N41 41.018

Longitude: W85 36.237

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
MYSP2	3			
CEDE4	3			
LEMN	2			
POPE6	2			

Individual Plant Bed Survey

Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifier

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Weed Control

Aquatic Vegetation Plant Bed Data Sheet

Page 6 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: E1

Waterbody Name: Shipshewana

Bed Size: ~ 1 acre

Substrate: 1

Waterbody ID:

Marl? 0

Total # of Species 4

High Organic? 1

Canopy Abundance at Site

S: - N: - F: - E: 4

SITE COORDINATES

Center of the Bed

Latitude: 40.943

Longitude: 36.007

Max. Lakeward Extent of Bed

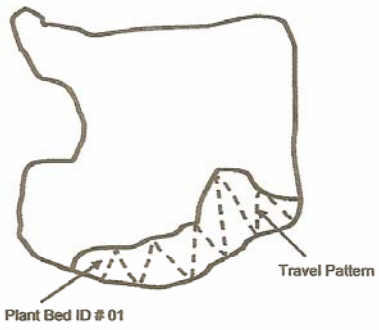
Latitude: 40.934

Longitude: 36.023

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
cattail	2			
Spatterdock	3			
Arrowhead	1			
Softstem Bulrush	1			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 7 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: E 2

Bed Size: ~4 acres

Substrate: 1

Marl? 0

High Organic? 1

Waterbody Name: Shipshewana

Waterbody ID:

Total # of Species 9

Canopy Abundance at Site

S: – N: – F: – E: 4

SITE COORDINATES

Center of the Bed

Latitude: N41 41.073

Longitude: W85 36.042

Max. Lakeward Extent of Bed

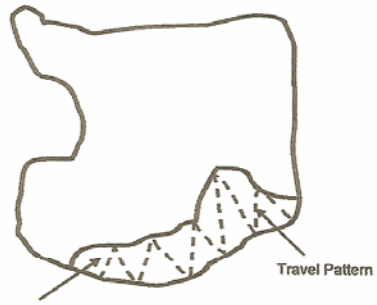
Latitude: N41 41.063

Longitude: W85 36.037

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
LEMN	1			
NYTU	2			
cattail	3			
Spatterdock	2			
Iris	1			
Arrowhead	1			
Willow sp	1			
Softstem Bulrush	1			
Watermeal	1			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Vegetation Plant Bed Data Sheet

Page 8 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: E3

Waterbody Name: Shipshewana

Bed Size: ~ 10 ac

Substrate: 1

Waterbody ID:

Marl? 0

Total # of Species 6

High Organic? 1

Canopy Abundance at Site

S: – N: 1 F: 3 E: 3

SITE COORDINATES

Center of the Bed

Latitude: N41 41 454

Longitude: W85 36 647

Max. Lakeward Extent of Bed

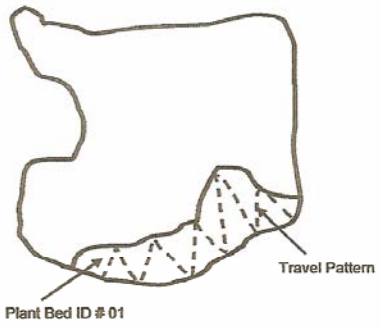
Latitude: N41 41 433

Longitude: W85 36.645

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
spatterdock	3			
Cattail	2			
NYTU	1			
Iris	1			
LEMN	1			
watermeal	1			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Weed Control

Aquatic Vegetation Plant Bed Data Sheet

Page 9 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: E 4

Waterbody Name: Shipshewana

Bed Size: 1 acre

Substrate: 1

Waterbody ID:

Marl? 0

Total # of Species 2

High Organic? 1

Canopy Abundance at Site: S: – N: – F: 4 E: –

SITE COORDINATES

Center of the Bed

Latitude: N41 40.909

Longitude: W85 36.425

Max. Lakeward Extent of Bed

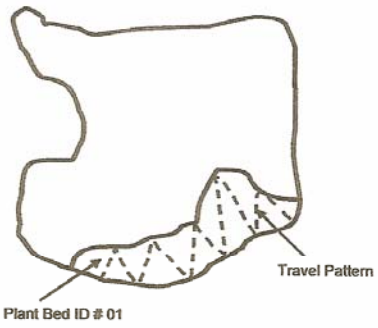
Latitude: N41 40.916

Longitude: W85 36.420

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NYTU	2			
Spatterdock	3			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

Aquatic Weed Control

Aquatic Vegetation Plant Bed Data Sheet

Page 10 of 10

State of Indiana Department of Natural Resources

ORGANIZATION: Shipshewana

DATE: 5/17/06

SITE INFORMATION

Plant Bed ID: E5

Waterbody Name: Shipshewana

Bed Size: ~2.5 ac

Substrate: 1

Waterbody ID:

Marl? 0

Total # of Species 4

High Organic? 1

Canopy Abundance at Site

S: - N: 2 F: - E: 3

SITE COORDINATES

Center of the Bed

Latitude: N41 40.874

Longitude: W85 36.187

Max. Lakeward Extent of Bed

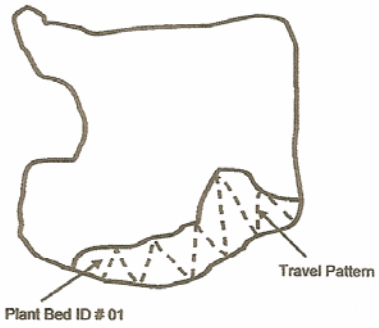
Latitude: N41 40.882

Longitude: W85 36.147

SPECIES INFORMATION

Species Code	Abundance	QE	Vchr.	Ref. ID
NYTU	2			
Spatterdock	3			
Arrowhead	2			
Cattails	2			

Individual Plant Bed Survey



Comments:

REMINDER INFORMATION

Substrate:
1 = Silt/Clay
2 = Silt w/Sand
3 = Sand w/Silt
4 = Hard Clay
5 = Gravel/Rock
6 = Sand

Marl
1 = Present
0 = absent

High Organic
1 = Present
0 = absent

Overall Surface Cover
N = Nonrooted floating
F = Floating, rooted
E = Emergent
S = Submersed

Canopy:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

Abundance:
1 = < 2%
2 = 2-20%
3 = 21-60%
4 = > 60%

QE Code:
0 = as defined
1 = Species suspe
2 = Genus suspected
3 = Unknown

Voucher:
0 = Not Taken
1 = Taken, not varified
2 = Taken, varifie

Reference ID:
Unique number or letter to denote specific location of a species; referenced on attached map

16.9 Permit Application

APPLICATION FOR AQUATIC VEGETATION CONTROL PERMIT

State Form 26727 (R4 / 2-04)
Approved State Board of Accounts 2004
[X] Whole Lake [ ] Multiple Treatment Areas
Check type of permit

INSTRUCTIONS: Please print or type information

FOR OFFICE USE ONLY
License No.
Date Issued
Lake County

Return to: Page 1 of
DEPARTMENT OF NATURAL RESOURC
Division of Fish and Wildlife
Commercial License Clerk
402 West Washington Street, Room W2
Indianapolis, IN 46204

FEE: $5.00

Applicant's Name	Lake Assoc. Name	
Steven Weiderman	Shipshewana Lake Association	
Rural Route or Street		Phone Number
3560 North 920 West		260-768-9137
City and State		ZIP Code
Shipshewana		46565
Certified Applicator (if applicable)	Company or Inc. Name	Certification Number
Jim Donahoe	Aquatic Weed Control	F-19215
Rural Route or Street		Phone Number
P. O. Box 325		574-533-2597
City and State		ZIP Code
Syracuse IN		46567

Lake (One application per lake)	Nearest Town	County
Shipshewana	Shipshewana	Lagrange

Does water flow into a water supply [ ] Yes [X] No

Please complete one section for *EACH* treatment area. Attach lake map showing treatment area and denote location of any water supply int

Treatment Area # 1	LAT/LONG or UTM's Whole Lake	
Acres to be trolled Whole	Proposed shoreline treatment length (ft) Whole	Perpendicular distance from shoreline (ft) Whol
Maximum Depth of Treatment (ft) 5	Expected date(s) of treatment(s) late june	

Treatment method: [X] Chemical [ ] Physical [ ] Biological Control [ ] Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Sonar / Avast

Plant survey method: [X] Rake [ ] Visual [ ] Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community
Eurasian Milfoil	X	50
Coontail	X	40
Algae	X	10

Aquatic Weed Control

Page ____ of

Treatment Area #	LAT/LONG or UTM's	
Total acres to be ...rolled	Proposed shoreline treatment length (ft)	Perpendicular distance from shoreline (ft)
...imum Depth of Treatment (ft)	Expected date(s) of treatment(s)	

Treatment method: ☐ Chemical ☐ Physical ☐ Biological Control ☐ Mechanical

Based on treatment method, describe chemical used, method of physical or mechanical control and disposal area, or the species and stocking rate for biological control. Reward, Aquathal K, Copper sulfate, 2-4D, renovate, Nautique

Plant survey method: ☐ Rake ☐ Visual ☐ Other (specify)

Aquatic Plant Name	Check if Target Species	Relative Abundance % of Community

INSTRUCTIONS: Whoever treats the lake fills in "Applicant's Signature" unless they are a professional. If they are a professional company who specializes in lake treatment, they should sign on the "Certified Applicant" line.

Applicant Signature	Date
Certified Applicant's Signature	Date

FOR OFFICE ONLY

☐ Approved ☐ Disapproved	Fisheries Staff Specialist
☐ Approved ☐ Disapproved	Environmental Staff Specialist

Mail check or money order in the amount of $5.00 to:

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF FISH AND WILDLIFE
COMMERCIAL LICENSE CLERK
402 WEST WASHINGTON STREET ROOM W273
INDIANAPOLIS, IN 46204


DeLORME
Street Atlas USA® 2004 Plu
W 375 N
W 350 N
W 335 N
W 325 N
W 270 N
W 260 N
W 250 N
N 1000 W
N 900 W
N 800 W
N 700 W
N 600 W
N 500 W
N 400 W
N 300 W
N 200 W
N 100 W
N 986 W
N 915 W
N 829 W
N 686 W
N 515 W
N 525 W
Shipshewana Lake
Beatys Beach
Mather Ditch
PARKVIEW ST
United Brethren Camp
Wolfe Fie
© 2003 DeLorme. Street Atlas USA® 2004 Plus.
www.delorme.com
TN
MN (4.9°W)
Scale 1 : 12,000